Ecozones of Canada

Arctic Cordillera Ecozone

Ice and rock reign supreme in the Arctic Cordillera Ecozone, an area featuring some of the world's most spectacular mountain glacial scenery. Massive ice caps and tonguing glaciers mask many of the rugged mountains. Some of Canada's highest but least-known peaks are found here, towering over gaping U-shaped valleys and deep fjords that extend many kilometres inland.

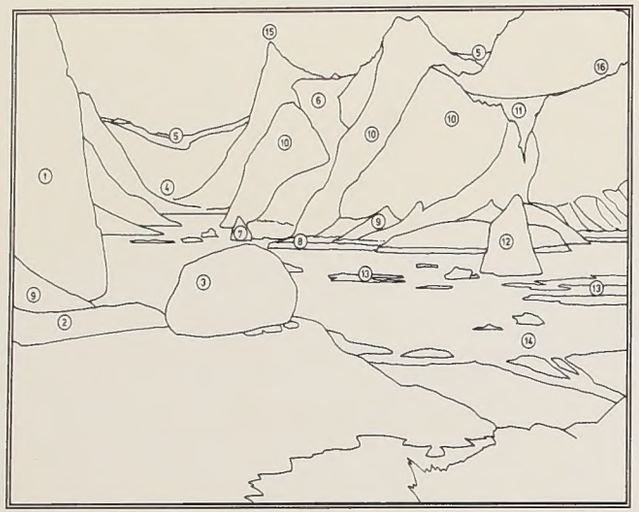
A vast mountain chain forms the spine of this ecozone. It runs along the northeastern fringe of the Northwest Territories and Labrador, dominating Labrador, eastern Baffin, and Devon islands and most of Ellesmere and Bylot islands. Because of the extreme cold, high winds, and lack of soil, the higher portions of this ecozone are largely devoid of plants and animals. Ice barrens and frost-shattered rock prevail over much of the landscape.

At lower elevations, pockets of tundra meadow dotted with arctic flowers and ground-hugging shrubs occupy sheltered valleys, streambanks and coastlines. During the brief arctic summer, these sites are oases of concentrated life.

In contrast to the biological impoverishment of the land, the adjacent fjords and nearshore waters are richly endowed with marine life. Complex current systems, localized upwellings of nutrients, and "polynyas" (which remain ice-free year round) create the Arctic's most productive aquatic ecosystems. Among the animals living here are globally significant populations of Polar Bear, Narwhal Whale, and the endangered Bowhead Whale.

Although elements of the last ice age persist in the Arctic Cordillera, the region is a land of surprising vitality. Even the ice itself can come alive to the eyes and ears of patient observers.

ARCTIC ROCKIES



1. *Sedimentary rock*
2. *Moraine*
3. *Glacial erratic*
4. *U-shaped valley*
5. *Ice cap*
6. *Valley glacier*
7. *Calved ice from glacier*
8. *Raised beach*
9. *Talus slope*
10. *Granitic and metamorphic rock*
11. *Cirque glacier*
12. *Iceberg*
13. *Sea ice*
14. *Outwash fan*
15. *Horn*
16. *Arete*

LANDFORMS AND CLIMATE

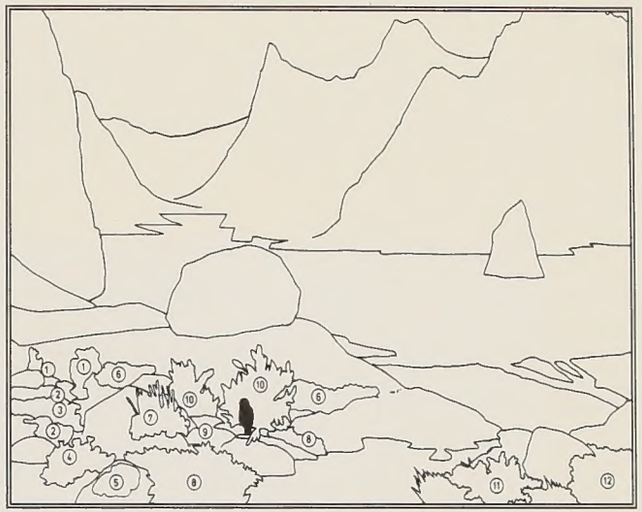
The ecozone contains one of Canada's two major mountain chains. The mountains of the Arctic Cordillera span two geological "provinces," each with its own distinctive rock type. The mountains of volcanic rock rangein age from 1.2 billion to 65 million years old. The mountains of southeastern Ellesmere and eastern Baffin Island belong to the older Churchill province, which is typified by Canadian Shield rock, a mix of granites, metamorphic gneisses, and ancient sediments.

Glacial ice engulfed northern Canada near the beginning of the Pleistocene epoch 2 million years ago. Since then, huge glaciers, far exceeding the depth and extent of present ones, have swept over this landscape at least four times.

The main paths of the Pleistocene glaciers are marked by deep U-shaped valleys, which in coastal areas merge with steep-sided fjords that may rise over 1 000 metres above the sea. Past and present glaciers have created bowl-like cirque basins, pyramidal peaks called horns, knife-edged ridges or aretes, and other landforms.

After being depressed into the Earth's crust by the colossal weight of Pleistocene ice, the landscape is now rising, in places by as much as 30 cm per century. Raised beaches now well back from existing shorelines attest to this continuing process.

The climate is typically harsh, with long, extremely cold winters and short, cool summers, although the brief summer growing season is enhanced by long periods of daylight. Only July and August have mean daily temperatures above the freezing point. Eureka, Canada's coldest and most northerly weather station, has an average annual temperature of -19.7°C and a February mean monthly temperature of -38°C. A typical year sees just 250 mm of precipitation, although it is much higher in Labrador.



1. *Arctic Poppy*
2. *Purple Saxifrage*
3. *Mountain Avens*
4. *Diapensia*
5. *Crustose Lichens*
6. *Cottongrass*
7. *Mountain Sorrel*
8. *River Beauty*
9. *Moss Campion*
10. *Arctic Willow*
11. *Bilberry*
12. *Arctic White Heather*

PLANTS

Ice and bald rock dominate 75% of the Arctic Cordillera. For plants and animals, this is one of the most inhospitable places on earth. To the north, ice caps prevail; to the south, glaciers are more common. Even lichens, which as a group are immensely adaptable, are largely absent from the area. Summer lasts just a few weeks and killing frosts are not unknown throughout the season. The average July temperature is only 5°C. Soils are virtually non-existent over much of the area due to ice cover and the slow rate of soil formation. Moreover, the area receives about the same amount of precipitation as the Sahara desert. What little moisture there is in the soil, or in plants themselves, is liable to be sucked away by fierce arctic winds.

In spite of the generally severe conditions, several hardy plant species flourish where moisture, heat, and nutrients create favourable microhabitats. Isolated pockets of biological productivity can be found in sheltered streambanks and coastlines, south-facing slopes watered by late-melting snow, and fertilized areas near animal dens and bird perching sites.

Arctic plants share several characteristics that help them cope with the extreme conditions. Most hug the ground to avoid the chilling and drying effects of summer winds and to ensure protection beneath the snow in winter. Some species grow in dense mats or cushions, creating tiny forests where temperatures can be 10°C to 20°C warmer than the air just above the plants. For added insulation, many species are covered with thick heat-trapping and wind-stopping hairs.

For those who know where to look, this seemingly desolate landscape will yield surprising floral treasures. Once discovered, the best way to enjoy them is on hands and knees, since few plants reach the height of a hiking boot. The inevitable rewards in colour, fragrance, and, in some cases, taste will make the search worthwhile.

1. *Thick-billed Murre*
2. *Beluga Whale*
3. *Northern Fulmar*
4. *Hoary Redpoll*
5. *Snow Bunting (female in foreground)*
6. *Common Ringed Plover*
7. *Walrus*
8. *Ringed Seal*
9. *Common Eider*
10. *Black Guillemot*
11. *Narwhal*
12. *Polar Bear*

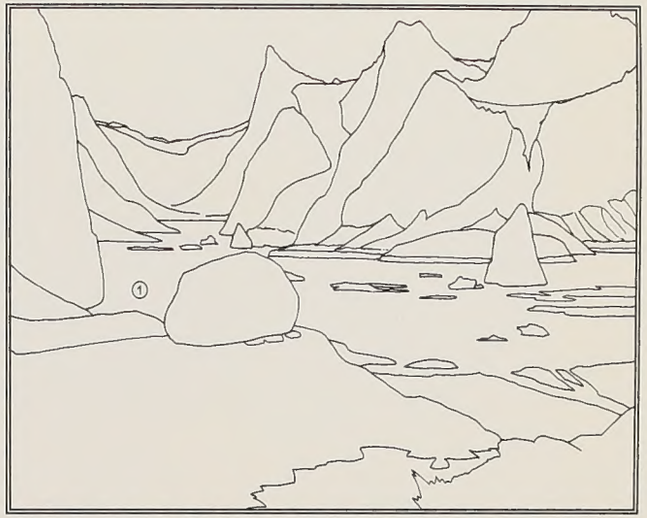
WILDLIFE

Land mammals are rare in the Arctic Cordillera. This is due mainly to the sparse plant life, which is the foundation of all mammalian food chains. Arctic Hare, Arctic Fox, Ermine, and the Collared Lemming are among the few species to call the region home. However, their densities and abundance are generally much lower than in arctic habitats endowed with more plant cover. In most cases these animals thrive in pockets of higher plant productivity along moist sheltered streams and coastal areas.

Also favouring these habitats are the few species of songbirds and shorebirds that come to the far north to breed. Most common are Hoary Redpoll, Little Ringed Plover, and Snow Bunting.

This ecozone is mainly devoid of large land mammals, although in coastal areas the occasional Polar Bear strays as far as 100 km inland. For the most part, Polar Bears stay close to the sea, where biological productivity is many times higher than on land. In spring and early summer, Polar Bears take to the water and drifting ice floes in search of Ringed and Bearded Seals, their preferred prey. When the ice breaks up in August, Polar Bears come ashore to feed on mussels, starfish, birds' eggs, and carrion. Though Polar Bears are usually solitary, a beached Bowhead Whale carcass may attract a group of over 40 bears.

Besides Polar Bears, seals, and whales, the region's unusually productive marine waters support large concentrations of seabirds, which congregate by the thousands. The waters surrounding Bylot Island and within Lancaster Sound support huge breeding colonies of Northern Fulmars, Thick-billed Murres, and Black-legged Kittiwakes.



1. *Subsistence hunting, trapping, and fishing*

HUMAN ACTIVITIES

Canada's Arctic Cordillera Ecozone is one of the world's most sparsely populated areas. The communities of Broughton Island and Clyde River are home to only about 1 000 people (1991).

The Inuit, who have occupied the region for 1 000 years or more, form over 80% of the population. They consist of regional groups that share a unique heritage and one language with several dialects.

Arctic communities feature a mixture of traditional and cash economies. Much of the local population depends on subsistence hunting, trapping, and fishing – activities highly valued for their contributions to independence, self-esteem, tradition, and a healthy lifestyle. Residents are also involved in mining, oil and gas development, construction, services, and government activities. Those Inuit employed full-time as wage earners turn to weekend and part-time hunting to supplement their diet with preferred meats. Some tourism is linked with Bylot Island and Auyuittuq national parks.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

1. ARCTIC ROCKIES

FURTHER READING

Anon. 1990. Northwest Territories Data Book. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-23-2.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto, Ont. ISBN 0-8020-2137-9.

Boden, J.F. and E. Boden, eds. 1991. Canada North of Sixty. McClelland and Stewart Inc. Toronto, Ont. ISBN 0-7710-1581-X.

Bone, R. 1992. The Geography of the Canadian North. Oxford University Press. London. ISBN 0-19-540772-5.

Burt, P. 1991. Barrenland Beauties. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-25-9.

Douglas, R.J.W., ed. 1970. Geology and Economic Minerals of Canada – Economic Geology Report No. 1. Geological Survey of Canada. Ottawa, Ont.

Godfrey, W.E. 1986. The Birds of Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-10758-9.

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada. Ottawa, Ont.

Porsild, A.E. and W.J. Cody. 1980. Vascular Plants of Continental Northwest Territories, Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-00119-5.

Renewable Resources. Various dates. NWT Wildlife Sketches. (Thirteen brochures on selected wildlife species.) Government of the Northwest Territories. Yellowknife, N.W.T.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid, V. Neimanis, John Anderson, Gary Ironside and others – while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

The text was edited by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council onEcological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

Printed at Transcontinental Printing Inc., Kanata, Ont.

Northern posters are adapted and reproduced by permission from CYGNUS Environmental Consulting, Yellowknife.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires ecologiques

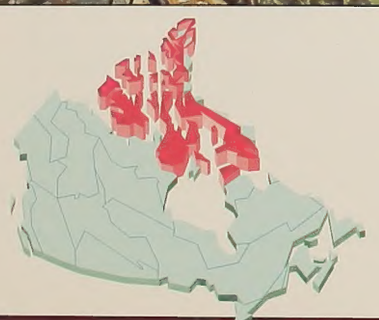
ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada

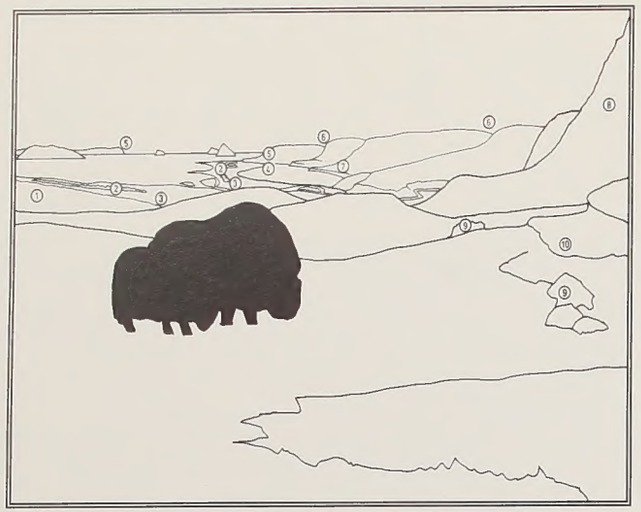
Northern Arctic Ecozone

Covering 1.5 million square kilometres, or about one seventh of Canada, the Northern Arctic Ecozone extends over most of the nonmountainous areas of the arctic islands and parts of northeastern Keewatin, western Baffin Island, and northern Quebec. It is among the largest arctic ecosystems in the world. Winters pass in near darkness with the polar night measured in weeks and months rather than hours. Snow may fall any month of the year and usually remains on the ground from September to June. Extremely low temperatures and an average precipitation of about 200 mm per year characterize the climate. When not covered in snow, much of the landscape is typified by barren plains covered in frost-patterned soils and the occasional rock outcrop.

A desolate, cold, and dry land seemingly devoid of life – such might be a visitor's first impression. But to those who have seen the colourful profusion of wildflowers along an arctic stream, heard the tinkling call of the ascending Horned Lark, or watched a herd of Muskoxen stand resolute against a fierce winter blizzard, this land is alive and full of wonder.



FAR NORTH



1. *Felsenmeer (frost-shattered rock)*
2. *Boulder barricade*
3. *Coastal plain*
4. *Patterned ground*
5. *Scarp*
6. *Dissected plateau*
7. *Raised beach terraces*
8. *Sedimentary outcrop*
9. *Frost-heaved rock*
10. *Solifluction lobes*

LANDFORMS AND CLIMATE

Much of the Northern Arctic Ecozone consists of low rolling plains covered with soil and rock debris left by glaciers. In these areas, the landscape may be covered by nothing more than frost-patterned soils, frost-shattered limestone, and sandstone for hundreds of square kilometres. The area has numerous landscape features more commonly associated with the badlands of the American southwest.

Many coastlines are characterized by wide flat plains that extend up to 10 km inland. Most of these coastal plains were once submerged beneath the sea. Following their release from the crushing weight of glacial ice, they have rebounded over the past few thousand years. Ancient beach terraces that now lie far from shore testify to the uplifting. Some shorelines are closely paralleled by lines of "boulder barricades" pushed there by sea ice carried ashore by strong tides and storm waves.

Broad plateaus are common in the interior area. They often show deepV-shaped cuts along their shoulders where past or present streamflows have cut through their sedimentary layers. On some islands, the plateau edges are sheer cliffs that create inaccessible coastlines. Some cliffs located beside productive marine waters provide protected nesting habitat for colonies of seabirds such as Thick-billed Murres and Northern Fulmars.

Perennial frozen ground known as permafrost lies beneath the entire ecozone. Under a thin active layer, which freezes in winter and thaws each summer, permafrost may extend almost 1 km downwards. The constant freezing and thawing creates unstable soils that form cell-like shapes known as "patterned ground."

Summers are short and cold, with mean daily temperatures above freezing only in July and August. Daily winter temperatures average less than -30°C in the coldest area of this ecozone, the northern islands. Snow cover usually lasts from September to June, but it can fall during any month. Annual ecozone precipitation is less than 250 mm except in southeast Baffin and Labrador where it can exceed 500 mm. While the northern islands have the least precipitation of the arctic ecozones, moisture is plentiful – in lakes and rivers, in muskegs and permafrost, in the snow cover, in the permanent ice, and in the Arctic Ocean.

1. *Arctic Poppy*
2. *Purple Saxifrage*
3. *Mountain Avens*
4. *Moss Campion*
5. *Arctic Daisy*
6. *Crustose Lichens*
7. *Arctic Willow*
8. *White Arctic Heather*
9. *Arctic Bladder Campion*
10. *Yellow Oxytrope*
11. *Sedges*
12. *Cotton Grass*
13. *Mastodon Flower*
14. *Arctic Lousewort*
15. *Mountain Sorrel*
16. *Pygmy Buttercup*
17. *River Beauty*
18. *Chickweed*

PLANTS

Plant life in the Northern Arctic Ecozone is generally sparse and stunted. Plant colonization is impossible for all but the hardiest of species, due to the exceedingly dry climate, permafrost, frost-churned and calcareas soils, and gale force winter winds. Not surprisingly, the number of plant species is very low – only about 140 species compared with 3 000 in southern Canada. Moss and lichen, however, seem to thrive in this ecosystem. Over 600 species are found in the Northern Arctic compared with about 500 in the more temperate latitudes.

Although much of this region is virtually devoid of plants, relatively lush "oases" are found scattered across the landscape. These oases are confined mainly to coastal lowlands, sheltered valleys, and moist, nutrient-rich corridors along streams and rivers. They often support thick hummocky carpets of sedges, mosses, and lichens and are vital to many species of wildlife.

Arctic plants have developed numerous adaptations to this harsh ecosystem. Nearly all species are perennial because too little energy is received for plants to germinate, bloom, and produce seeds during one brief summer. To avoid the chilling arctic winds, most plants are very short. Woody species such as the Arctic Willow assume a ground-hugging form. Others, such as Moss Campion and Yellow Oxytrope, grow in dense cushions or mats that reduce heat loss caused by the wind.

A particularly well-adapted plant found throughout this region is the Arctic Poppy. Its parabolic shape, heat-absorbing centre, and ability to track the sun's movements through the sky make it a natural solar collector, raising its internal temperature by up to 10°C and hastening the formation and ripening of seeds. This strategy further promotes reproduction by attracting pollinating insects that come to bask in the flower's warmth.

1. *Long-tailed Jaeger*
2. *Glaucous Gull*
3. *Muskox*
4. *Short-tail Weasel or Ermine*
5. *Horned Lark*
6. *Collared Lemming*
7. *Black-bellied Plover*
8. *Ruddy Turnstone*
9. *Red Phalarope*
10. *Oldsquaw*
11. *Brant*
12. *Snow Goose*
13. *Arctic Hare*
14. *Peary Caribou*
15. *Polar Bear*
16. *Snowy Owl*
17. *Arctic Fox*
18. *King Eider*
19. *Red-throated Loon*

WILDLIFE

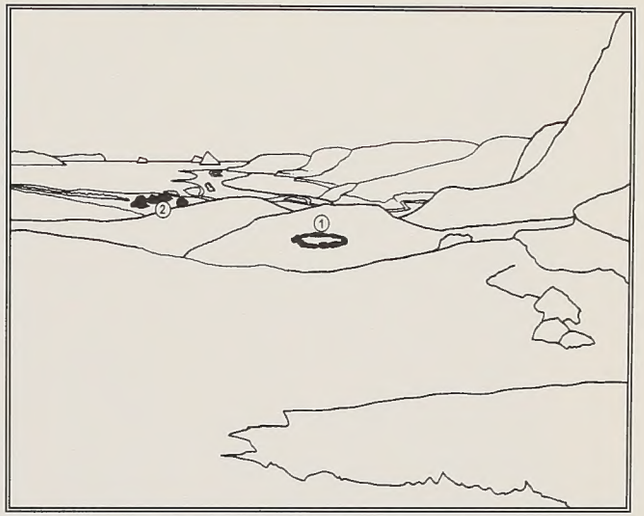
The extreme cold, harsh soils, and limited plant communities of the Northern Arctic are reflected in the relatively low diversity and abundance of mammals. Of the approximately 200 species of mammals found in Canada, fewer than 20 occur in the ecozone. There are few insect species and a total absence of reptiles and amphibians.

This land at first may appear to be empty of life, particularly in winter. But three large mammals – the Muskox, Caribou, and Polar Bear – are very much at home here throughout the year.

Muskoxen are found across much of the Northwest Territories portion of the area. They roam the plains and plateaus in small bands or individually during the summer, and in larger family groups in the fall and winter. Peary Caribou, found only on the high arctic islands, are smaller and more pale than the Barren-ground Caribou which inhabit the mainland of the Northwest Territories, Baffin Island, Quebec, and Labrador. Although they lack the spectacular mass migrations of many Barren-ground Caribou herds, most Peary Caribou make seasonal movements of up to several hundred kilometres between arctic islands. Polar Bears also range widely as they journey along coastal areas or follow the sea ice in search of seals.

The only small mammal hardy enough to survive the harsh climate of this region is the Collared Lemming. It seeks protection from frigid winter temperatures under a protective blanket of snow. Lemmings are active all winter, scurrying through tunnels to their well-stocked food chambers. To the Arctic Fox, Ermine, and birds such as the Gyrfalcon and Snowy Owl, they are a vital source of food. A reduction in lemming numbers, caused by severe weather or as yet unexplained population cycles, can have a ripple effect in many arctic food chains.

In spring, the land reverberates with the sound of thousands of migrant birds. Immediately after arrival, they begin a frantic schedule of breeding, nesting, and rearing young. Snow Geese, Brant, and Canada Geese nest in moist wetlands that line coastal areas and river valleys. Eider and Oldsquaw Ducks nest beside small ponds on grassy tundra. These areas also support a surprising number of shorebirds, including the Black-bellied Plover, Ruddy Turnstone, and Red Phalarope. Hoary Redpolls, Horned Larks, and Snow Buntings need very little vegetation cover for nesting and thus can survive in even the most sparse arctic landscape.



1. *Tent ring*
2. *Camp*

HUMAN ACTIVITIES

Canada's Northern Arctic Ecozone is among the least populated areas of the world. The total population, scattered in 20 communities, is only about 15 000 people (1991). Iqaluit is the largest centre, with a population numbering 3 552 in 1991.

The Inuit, who have occupied the area for a thousand years or more, form over 80% of the population. They consist of regional groups that share a unique heritage and one language with several dialects.

Arctic communities feature a mixture of traditional and cash economies. Much of the local population depends on subsistence hunting, trapping, and fishing, activities highly valued for their contributions to independence, self-esteem, tradition, and a healthy lifestyle. However, residents are also involved in mining, oil and gas development, construction, services, and government activities. Those Inuit employed full-time as wage earners turn to weekend and part-time hunting to supplement their diet with preferred meats.

The arctic ecozones, representing Canada's last natural resource frontier, are rich in mineral and hydrocarbon reserves. However, since 1989, the value of metallic mineral production has plummeted because of a weak global market. Two mines are currently operating in the Northern Arctic Ecozone: the base metal Polaris mine on Little Cornwallis Island, and the Nanisivik mine on Baffin Island. Despite their locations, they are among the lowest-cost zinc producers in the world.

The arctic ecozones also have 59% of Canada's estimated oil resources and 48% of potential gas resources. Yet there has been no substantial development since the 1980s. This is largely due to external factors, such as low crude oil prices and the global recession. Tourism is also significant to the economy, generating $11.8 million for arctic businesses in 1993.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km^2). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km^2) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

2. FAR NORTH

FURTHER READING

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto, Ont. ISBN 0-8020-2137-9.

Boden, J.F. and E. Boden, eds. 1991. Canada North of Sixty. McClelland and Stewart Inc. Toronto, Ont. ISBN 0-7710-1581-X.

Bone, R. 1992. The Geography of the Canadian North. Oxford University Press. London. ISBN 0-19-540772-5.

Burt, P. 1991. Barrenland Beauties. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-25-9.

Douglas, R.J.W., ed. 1970. Geology and Economic Minerals of Canada: Economic Geology Report No. 1. Geological Survey of Canada. Ottawa, Ont.

Godfrey, W.E. 1986. The Birds of Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-10758-9.

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada. Ottawa, Ont.

Porsild, A.E. and W.J. Cody. 1980. Vascular Plants of Continental Northwest Territories, Canada. National Museums of Canada. Ottawa,Ont. ISBN 0-660-00119-5.

Renewable Resources. Various dates. NWT Wildlife Sketches. (Thirteen brochures on selected wildlife species.) Government of the Northwest Territories. Yellowknife, N.W.T.

Sirois, J. and D. McRae. 1994. The Birds of the Northwest Territories – A Miniguide to a Megaterritory and a checklist. Canadian Wildlife Service. Yellowknife, N.W.T.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid, V Neimanis, John Anderson and Gary Ironside and others – while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

The text was edited by West Hawk Associates in Ottawa.

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

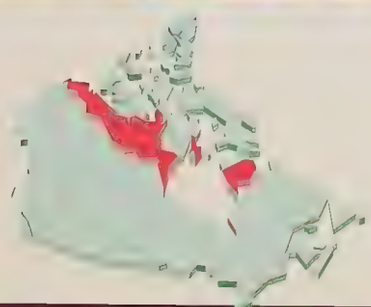
Northern posters are adapted and reproduced by permission from CYGNUS Environmental Consulting, Yellowknife.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



TREELESS NORTH

Southern Arctic Ecozone

When the first European visitors confronted Canada's Arctic they called it the Barren-lands. Forming the southern fringe of this massive ecosystem, the Southern Arctic ecozone may indeed seem barren when viewed from a distance. This is a place where nature's abundance and diversity are subdued by the harsh climate and terrain. But look closely at this landscape during the sudden greening of spring, the endless days of summer, or the brief blush of fall, and you will discover a land of plenty.

For almost a million square kilometres, the pattern of habitats in the Southern Arctic is the same: sprawling shrublands, wet sedge meadows, and cold, clear lakes. Superimposed on this pattern are the fascinating shapes and textures created by intense frost action in the soil.

The Northwest Territories portion of the Southern Arctic Ecozone is home to the world's biggest concentration of free-roaming large mammals. These are Barren-ground Caribou, the so-called "Buffalo of the Tundra." They began their annual migration cycle through this area soon after the last ice age ended. Evidence of that age is still plainly visible in the glacial etchings and deposits found throughout the region.

For thousands of years, abundant large mammals lured hunters from both sides of the treeline. The Dene and Inuit used its great rivers – the Thelon, Back, and Coppermine – to reach Caribou, Muskox, and Moose. They came most often in the fall to secure the large supplies of meat necessary to carry them through the winter. Though floatplanes are now the main mode of access, the rivers are still used by people from all walks of life to enjoy the beauty and bounty of the frontier.

1. *Esker*
2. *Kettle pond*
3. *Patterned ground*
4. *Glacial erratic*
5. *Bouldery moraine*
6. *Hummocks*
7. *Frost-heaved boulders*
8. *Mud boil*
9. *Exposed granitic bedrock*
10. *Glacial striations*

LANDFORMS AND CLIMATE

The last glaciers finally retreated from this area about 8 500 years ago. As the 3-km thick ice sheet melted, it released a huge volume of soil and rock debris, which is now strung across the landscape in the form of corrugated piles of bouldery moraine, and etched by long eskers extending up to 100 km. Occurring less frequently are outwash aprons of crudely sorted sand and gravel, and raised beach ridges along the shores of phantom preglacial lakes. The resulting undulating terrain is studded with innumerable lakes and ponds. Some of these water bodies formed in "kettle" depressions created when ice blocks, abandoned by the main ice sheet, became engulfed by glacial drift and then melted away.

Occasionally emerging through this thick mantle of glacial deposits is the Canadian Shield, which consists mostly of granite bedrock. The most recent passage of the glaciers can still be read in these rocks, which often show fine lines in the bedrock carved by rock fragments embedded in the bottom of the advancing ice sheet.

On its journey south, the glacier plucked large chunks of rock from weak spots in the Canadian Shield. These rocks, some the size of houses, may have rafted along on top of the glacier, been bulldozed forward by its nose, or carried below. Dropped a few metres or a few thousand kilometres from their source, these rocks sometimes have little in common with the surrounding bedrock, hence the name "glacial erratic."

Permafrost occurs continuously throughout the Southern Arctic Ecozone. Lying sometimes just a few centimetres below the surface, it acts as a dam that stops the downward flow of water. Consequently, even though there is little precipitation here, the soils are often waterlogged or frozen. Repeated freezing and thawing of these soils creates interesting features on the surface, including cell-like polygons, bulging hummocks, and bare mud boils where the soil is so active that no plants can take root. Intense frost heaving often splits apart the underlying bedrock and forces large angular "boulders" to the surface.

Summers are short (about four months), cool, and moist, whereas winters are long and extremely cold. Total annual precipitation is usually less than 250 mm in the west and rarely more than 500 mm in the east.

1. *Black Spruce (stunted krummholz in background)*
2. *Fragrant Shield Fern*
3. *Shrub Birch*
4. *Crowberry*
5. *Bearberry*
6. *Moss Campion*
7. *Lichens*
8. *Labrador Tea*
9. *Blueberry*
10. *Mountain Cranberry*
11. *Cloudberry*
12. *Alpine Club Moss*
13. *Least Willow*
14. *Net-veined Willow*
15. *Blue-green Willow*
16. *Cotton grass*
17. *Sedges*

PLANTS

This ecozone is bounded to the south by the treeline, a broad ecological division between the taiga forest and the treeless arctic tundra. The treeline is not really a clear line but rather an irregular transition zone. Within the zone, small scattered clumps of stunted spruce trees grow on warmer, sheltered sites. They often appear in dense cushions less than a metre high that help protect them from the worst of winter winds. This form of tree growth is called krummholz, a German word meaning crooked wood.

Low precipitation and extremely low winter temperatures are among the factors that discourage tree growth in this ecozone. The near continuous blowing of cold, dry winds and the presence of permafrost also restrict plant growth. Low shrubs such as Willow, Shrub Birch, and Labrador Tea are well adapted to these conditions. Where soil is sufficiently developed, these plants form vast shrublands interspersed in lower areas with wet sedge meadows and ponds. On the most exposed sites, low shrubs give way to mats of lichens, mosses, and ground-hugging shrubs such as Mountain Cranberry and Least Willow.

Where hummocks, mud boils, patterned ground, and other permafrost-related features are present, interesting ribbons and circles of vegetation result in response to different amounts of moisture or levels of soil disturbance.

Subtle variations in the distribution, abundance and size of plants in the Southern Arctic Ecozone reflect their sensitivity to small changes in microclimate. The resulting tapestry of plants is best appreciated in the autumn when the tundra produces its rich display of reds, oranges, purples, and yellows. Berry picking is also at its best this time of year, when blueberries, cranberries, and bearberries are often found in great abundance.

1. *Rough-legged Hawk*
2. *Tundra Swan*
3. *Barren-ground Caribou*
4. *Wolverine*
5. *Arctic Ground Squirrel*
6. *American Tree Sparrow*
7. *Brown Lemming*
8. *Grizzly Bear*
9. *Lapland Longspur*
10. *Willow Ptarmigan*
11. *Semi-palmated Plover*
12. *Oldsquaw*
13. *Snow Bunting*
14. *Gyrfalcon*
15. *Wolf*
16. *Canada Goose*

WILDLIFE

Low biological productivity, a short growing season, and extremely cold, long winters impose severe demands on wildlife in the Southern Arctic. As a result, the number of resident bird and mammal species drops sharply as one moves beyond the trees onto the tundra. Food chains are relatively short and changes in the abundance of one species may profoundly affect another species. For instance, a cold, late spring drastically reduces the nesting success of Canada Geese. This causes trouble for Arctic Fox, which depends heavily on egg predation at this time of year.

For wildlife observers, unobstructed views of the animals that inhabit the area compensate for its relatively low number of species. Little can compare with the sight of the Barren-ground Caribou during their autumn migration.

Close to a million caribou migrate south each year, including the Bluenose, Bathurst, Beverly, and Qaminirjuaq herds in the Northwest Territories, the Porcupine herd of the northern Yukon, and the Leaf River and George River herds of northern Quebec and Labrador. They move from their summer calving grounds along the northern fringe of the ecozone to their winter range in the taiga forest. During migration, they travel in large groups, often using the many snake-like eskers as natural highways through the tundra.

Flocks of migrating ducks, loons, geese, and swans add to the brief spectacle of autumn on the edge of the tundra. Like Caribou, Willow Ptarmigan migrate only as far as the taiga forest to find food and shelter during the winter months. The brief summer sees the hatching of countless billions of insects. The broad silhouette of the Rough-legged Hawk is a familiar sight as it scans the mossy hummocks and shrublands for voles and lemmings.

A limited number of Grizzly Bears can be found in the Northwest Territories portion of the Southern Arctic Ecozone, as can Muskox and other prominent wildlife species. The Barren-ground Black Bear is common throughout Northern Quebec. Moose are also present, particularly along the treeline to the south. Polar Bears roam the coastal areas during the summer and venture onto the growing pack ice as winter sets in.

1. *Resource Exploration*
2. *Hunting Camp*

HUMAN ACTIVITIES

Canada's Southern Arctic Ecozone is one of the most sparsely populated areas of the world. The total population, scattered in 17 communities, numbers only about 10 000 people (1991). Rankin Inlet is the largest centre, with a population in 1991 of 1 706.

The Inuit, who have occupied the region for a thousand years or more, form over 80% of the population. They include regional groups sharing a common heritage and one language with several dialects.

Arctic communities feature a mixture of traditional and cash economies. Much of the local population depends on subsistence hunting, trapping, and fishing – activities valued for their contributions to independence, self-esteem, tradition, and a healthy lifestyle. Residents are also involved in mining, oil and gas development, construction, services, and government activities. Those Inuit employed full-time as wage earners turn to weekend and part-time hunting to supplement their diet with preferred meats.

The arctic ecozones, representing Canada's last natural resource frontier, are rich in mineral and hydrocarbon resources. Since 1989, however, the value of total metallic mineral production has fallen drastically due to a weak global market. The Lupin gold mine is now the only mine operating in the Southern Arctic Ecozone.

The arctic ecozones have 59% of Canada's estimated oil resources and 48% of potential gas resources, but there has been no substantial development since the 1980s. This is largely due to external factors, such as low crude oil prices and the global recession. Tourism is also significant to the economy, generating $11.8 million for arctic businesses in 1993.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

3. TREELESS NORTH

FURTHER READING

Anon. 1990. Northwest Territories Data Book. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-23-2.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto, Ont. ISBN 0-8020-2137-9.

Boden, J.F. and E. Boden, eds. 1991. Canada North of Sixty. McClelland and Stewart Inc. Toronto, Ont. ISBN 0-7710-1581-X.

Bone, R. 1992. The Geography of the Canadian North. Oxford University Press. London. ISBN 0-19-540772-5.

Godfrey, W.E. 1986. The Birds of Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-10758-9

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada. Ottawa, Ont.

Moon, B. 1975. The Canadian Shield. N.S.L. Natural Science of Canada Limited. Toronto, Ont. ISBN 0-9196-4408-2.

Padgham, W.A. 1987. Yellowknife Guidebook – A Guide to the Yellowknife Volcanic Belt and its Bordering Rocks. Indian and Northern Affairs Canada. Yellowknife, Ont.

Porsild, A.E. and W.J. Cody. 1980. Vascular Plants of Continental Northwest Territories, Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-00119-5.

Pruitt, W.O. 1983. Wild Harmony – The Cycle of Life in the Northern Forest. Western Producer Prairie Books. Saskatoon, Sask. ISBN 0-88833-101-0

Renewable Resources. Various dates. NWT Wildlife Sketches. (Brochures on selected wildlife species.) NWT Culture and Communications. Yellowknife, N.W.T.

Walker, M. 1984. Harvesting the Northern Wild. Outcrop. Yellowknife, Ont. ISBN 0-919315-10-0.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1996), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid, V. Neimanis, John Anderson, Gary Ironside and many others – while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

The text was edited by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

Northern posters are adapted and reproduced by permission from CYGNUS Environmental Consulting, Yellowknife.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

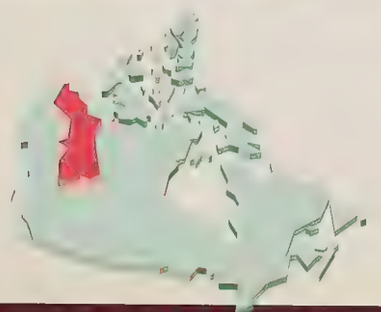
Environment Canada Environnement Canada

Taiga Plains Ecozone

The Taiga Plains Ecozone is an area of low-lying plains centred on Canada's largest river, the Mackenzie, and its many tributaries. With an area of about 550 000 square kilometres, it is Canada's sixth largest ecozone. Approximately 90% of the Taiga Plains is located in the western Northwest Territories, with small extensions into northeastern British Columbia and northern Alberta. It is bounded to the east by Great Bear and Great Slave lakes, to the west by the rolling foothills of the Mackenzie Mountains, to the north by the Mackenzie Delta, and to the south by the spruce forest of the Boreal Plains.

The northern reaches of the ecozone feature a rich diversity of plants, birds, and mammals from both the Subarctic and the Arctic. The southern portion is home to the world's largest Wood Bison herd, contains the only known nesting site of the endangered Whooping Crane, and encompasses the sprawling Peace-Athabasca Delta, a wetland habitat of global significance.

Settlement of the Taiga Plains began around 11 000 years ago, near the end of the last ice age. At this time the Paleo-Indian people began moving through an ice-free corridor that stretched down the Mackenzie Valley to the Peace-Athabaska area of western Alberta. Over the past 300 years, the area has played a major role in the northern fur trade, development of frontier oil and gas resources, and provision of a major water transportation route through northwestern Canada.



BIG VALLEY

1. *Slide scar*
2. *Sedimentary rock*
3. *Gully erosion*
4. *Abandoned stream channel*
5. *Shoreline slumping*

LANDFORMS AND CLIMATE

A northern extension of the flat interior plains that dominate the Prairie provinces, the Taiga Plains feature typically subdued relief consisting of broad lowlands and plateaus. The nearly level to gently rolling plains are occasionally interrupted by some of the larger river valleys, which can be hundreds of metres deep.

Underlying these landforms are horizontal beds of sedimentary rock consisting of various combinations and ages of limestone, shale,sandstone, and conglomerates. Many of the limestone deposits contain clearly visible fossils of marine creatures that lived here hundreds of millions of years ago. Trapped in isolated pockets and cracks within the sedimentary layers are rich natural reservoirs of oil and gas, created from the carbon residues of early life forms.

Several waves of glaciers over the region have left behind deposits of sand, gravel, and boulders. These glacial moraine areas predominate and occur in various forms and thicknesses, such as the elongated ridges called drumlins and undulating and low-relief hills. Alluvial deposits are common along major rivers and the braided networks of abandoned stream beds. Large wetlands and muskeg dominate the lowest areas. The organic soils found in the eskers of this ecozone are generally shallow, highly acidic, and nutrient-poor. The mineral soils are also poorly developed and often frozen.

The Taiga Plains Ecozone contains most of the Northwest Territories' two "great" lakes, Great Slave and Great Bear, which were carved by glaciers along the western margin of the Canadian Shield. Numerous smaller lakes dot the broad floodplains of the ecozone, which is crisscrossed with patterns of former meandering channels and crescent-shaped oxbow lakes. Other signs of the dynamic power of large rivers include steep, fast-eroding riverbanks and ice-scoured shores.

The ecozone experiences considerable variation in daylight over the course of a year. Areas north of the Arctic Circle endure at least one day in which the sun never rises and at least one in which it never sets.

The subarctic climate is characterized by short, cool summers and long, cold winters. Precipitation is low to moderate, averaging 250 to 500 mm a year across much of the ecozone. Snow and freshwater ice-cover persist for six to eight months annually.

1. *Paper Birch*
2. *Fire Snag*
3. *Willow*
4. *Wild Rose*
5. *Trembling Aspen*
6. *Tamarack*
7. *Green Alder*
8. *White Spruce*
9. *Arboreal Lichens*
10. *Balsam Poplar*
11. *Jack Pine*

PLANTS

Permafrost, where present, detracts from the soil's productivity by chilling it and creating waterlogged conditions in the thawed "active layer" near the surface. Taiga Plains plant communities are relatively simple, dominated by a few species well-adapted to poor soil conditions and the harsh subarctic climate.

Tree species of the northern taiga forest, or "land of little sticks," include Black Spruce, White Spruce, Jack Pine, Tamarack, Paper Birch, Trembling Aspen, and Balsam Poplar. Though less frequent, White Spruce and Balsam Poplar may grow to an impressive height and girth on the nutrient-enriched alluvial flats bordering rivers, rivalling the largest of trees found elsewhere in Canada. Willow and alder shrubs also flourish in this habitat.

Low shrubs are abundant throughout this ecozone and include many species of heathers, such as Labrador Tea and Leatherleaf, plus a wide array of berry-producing species, including Cranberries, Currants, and Blueberries. Lichens and mosses dominate the ground cover, often forming a thick continuous carpet. Wetlands feature various sedges and mosses.

Forest fires that destroy several thousand hectares of trees are not uncommon in this ecozone. On average, 1% of the Northwest Territories' forests burn every year. Many taiga plant species benefit from the regular cycle of fires, which can purge old, stagnant forests of insects and disease. The distinctive mosaic of forest types created by fires usually results in a boost to the overall productivity and diversity of habitats available to wildlife.

1. *Lynx*
2. *Snowshoe Hare tracks*
3. *Caribou antler*
4. *Gray Jay*
5. *Snowshoe Hare*
6. *Willow Ptarmigan*
7. *Wood Bison*
8. *Common Raven*
9. *Sharp-tailed Grouse*
10. *Wolves at Bison kill*
11. *Red Fox*
12. *Ptarmigan tracks*
13. *Boreal Chickadee*
14. *Short-tail Weasel or Ermine*
15. *Moose droppings*
16. *Moose*
17. *Moose-browsed willows*
18. *Red Squirrel*

WILDLIFE

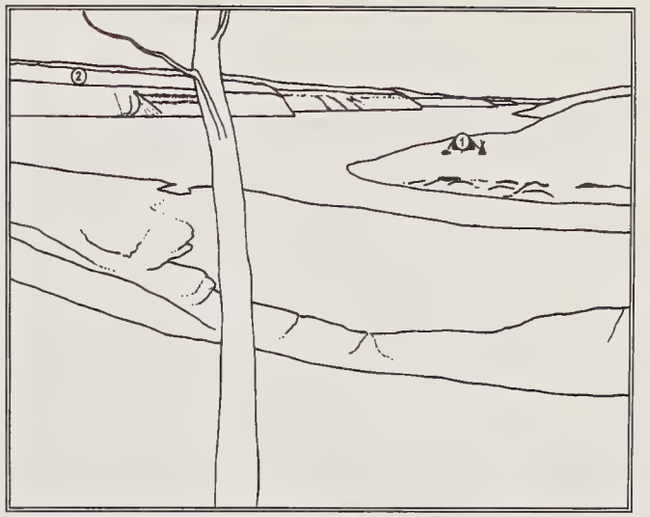
The islands and flood-enriched shores of the Mackenzie, Liard, and Slave rivers are favourite habitats for many wildlife species, including Moose. In summer, Moose feed mostly on aquatic vegetation in shallow waters. In winter, they browse heavily on shoreline willows, leaving behind abundant signs in the snow in the form of tracks, trails, droppings, and shed antlers.

Barren-ground Caribou from the Porcupine Herd overwinter in the northwest corner of this ecozone, while scattered groups of Woodland Caribou are found throughout the area during all seasons. Other common mammal species include Wolf, Red Fox, Snowshoe Hare, Lynx, Black Bear, Marten, Mink, Ermine, Wolverine, River Otter, Porcupine, Muskrat,Red Squirrel, Beaver, and Northern Red-backed Vole. Two thirds of the 3 000 Wood Bison in Canada range freely in the Mackenzie Bison Sanctuary along the eastern shore of Great Slave Lake.

Common bird species that breed here during the brief spring and summer include the Red-throated Loon (in the northernmost part), Ring-necked Duck, Greater Scaup, Canvasback, Sharp-tailed Grouse, Hawk Owl, Northern Shrike, and Fox Sparrow. During this time of year, fish-eating raptors such as the Bald Eagle, Peregrine Falcon, and Osprey are familiar sights as they soar above the shorelines. Hundreds of thousands of Ducks, Geese, and Swans use the region's many lakes, rivers, and wetlands as staging or nesting areas. The Mackenzie Valley forms one of North America's better-travelled migratory corridors for waterfowl breeding along the arctic coast.

Year-round bird species adapted to long, cold winters include the Common Raven, Sharp-tailed Grouse, Gray Jay, Common Redpoll, and Willow Ptarmigan. High insect populations make the ecozone a welcome breeding habitat for insect-eating forest birds and other insect eaters.

Lake Trout, Lake and Mountain Whitefish, Arctic Cisco, Longnose Sucker, Arctic Grayling, Dolly Varden, Burbot, Walleye, and Northern Pike are among the many fish species able to thrive in the Taiga Plain's cold, nutrient-poor lakes and rivers.



1. *Hunting camp*
2. *Forest potential*

HUMAN ACTIVITIES

The sparse human population of 22 000 is 60% aboriginal. Water access dictated the location of most communities in the Taiga Plains Ecozone. As a result, many are found in ecologically rich valleys and estuaries. Even the largest towns, such as Fort Nelson in British Columbia (3 804 residents) and Inuvik in the Northwest Territories (3 178), are immediately adjacent to vast tracts of pristine land. The few all-weather roads reach every community with a population over 1 000 persons, such as Hay River, Fort Smith, and Fort Simpson, all in the Northwest Territories.

Relatively few areas in the Taiga Plains are dominated by human activity. Much of the local economy is based on subsistence hunting, trapping, and fishing. However, the economy does include a small number of industrial activities such as mining, petroleum extraction, and, in recent years, forestry.

Fossil fuel reserves in the Mackenzie Valley are currently being exploited at the Pointed Mountain and Kotaneelee gas fields, located on the Liard Plateau, and at the Norman Wells oil field, which is Canada's fourth-largest producer.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20 Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1.
Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

4. BIG VALLEY

FURTHER READING

Anon. 1990. Northwest Territories Data Book. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-23-2

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto, Ont. ISBN 0-8020-2137-9.

Boden, J.F. and E. Boden, eds. 1991. Canada North of Sixty. McClelland and Stewart Inc. Toronto, Ont. ISBN 0-7710-1581-X.

Bone, R. 1992. The Geography of the Canadian North. Oxford University Press. London. ISBN 0-19-540772-5.

Douglas, R.J.W., ed. 1970. Geology and Economic Minerals of Canada – Economic Geology Report No. 1. Geological Survey of Canada. Ottawa, Ont.

Godfrey, W.E. 1986. The Birds of Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-10758-9.

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada. Ottawa, Ont.

Porsild, A.E. and W.J. Cody. 1980. Vascular Plants of Continental Northwest Territories, Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-00119-5.

Pruitt, W.O. 1983. Wild Harmony – The Cycle of Life in the Northern Forest. Western Producer Prairie Books. Saskatoon, Sask. ISBN 0-88833-101-0.

Renewable Resources. Various dates. NWT Wildlife Sketches. (Thirteen brochures on selected wildlife species.) Government of the Northwest Territories. Yellowknife, N.W.T.

Walker, M. 1984. Harvesting the Northern Wild. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-10-0.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid, V. Neimanis, John Anderson, Gary Ironside and others – while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

The text was edited by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontano

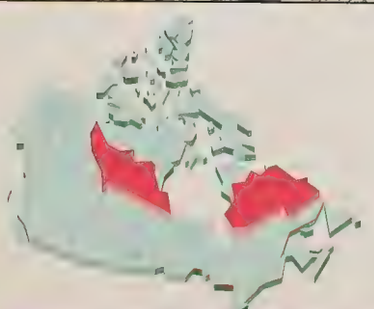
Northern posters are adapted and reproduced by permission from CYGNUS Environmental Consulting, Yellowknife

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



LAND OF DWARF TREES

Taiga Shield Ecozone

The Taiga Shield Ecozone stretches across part of Canada's subarctic north. The Russian term "taiga" refers to the northern edge of the boreal coniferous forest. This is the Athapaskan "land of little sticks" that stretches from Labrador to Alaska and from Siberia to Scandinavia. In northern Canada, much of this forest rests on the Canadian Shield, the bedrock heart of the continent. With an area of over 1.3 million square kilometres, the Taiga Shield is one of Canada's largest ecozones. One-third of it lies in the Northwest Territories.

The unique natural history of this area includes an unrivalled showcase of bald Precambrian bedrock that dates back to the planet's earliest days. Dotting the ancient landscape are millions of lakes and wetlands that were carved by successive waves of glacial erosion or which conform to natural depression in the bedrock. The Taiga Shield is an ecological crossroads where climates, soils, plants, birds, and mammals from two worlds – the Boreal and the Arctic – meet.

In the Northwest Territories, settlement of the ecozone began over 7 000 years ago as the Paleo-Indians followed Barren-ground Caribou northwards in the wake of receding glaciers. More recently, this area has played a major part in the story of Canada's development due to its pivotal role in the northern fur trade, its concentration of rich mineral resources, and its position as a cultural and political focal point for today's Aboriginal peoples, the Dene and the Inuit.

1. *Sedimentary rock*
2. *Whaleback*
3. *Glacial erratic*
4. *Frost cracking*
5. *Volcanic rock*
6. *Quartz vein displaced by minor fault*
7. *Glacial groove*
8. *Glacial striations*
9. *Chattermarks*
10. *Granitic rock*
11. *Volcanic pillows*
12. *Granodiorite dyke*

LANDFORMS AND CLIMATE

The Canadian Shield's massive rolling hills of ancient bedrock cover almost two-thirds of Canada. As monolithic as the Shield may seem, it is actually made up of seven distinct geological "provinces." The world's oldest rocks are found on the Taiga Shield in the Slave Geological Province north of Great Slave Lake. They were formed near the dawn of the Earth's geological history 4 billion years ago.

During the Precambrian Era, Shield rocks were warped, folded, and faulted by violent spasms in the Earth's crust. Since their birth, relentless weathering and erosion from countless rainstorms, rivers,floods, and the annual freezing and thawing cycle have worn down the rocks. In places, the Shield was repeatedly plucked and scoured by the advance of glaciers, leaving areas now frequently infilled as lakes. Elsewhere it was blanketed by boulders, gravel, and sand released by glaciers in retreat.

This story of geological creation and change is plainly recorded in exposed bedrock and surface deposits of the Taiga Shield. Volcanic rocks testify to the earliest eruptions of lava that created the Earth's crust as we know it. Some of these eruptions occurred under extreme water pressure at the bottom of ancient seas, creating globular "pillows" of lava. Vast areas of granite, once buried deep beneath the rock surface, reveal the power of billions of years of erosion. And the passage of mighty glaciers can be read by recognizing the striations and grooves etched in the rocks. Soils are usually shallow and coarse and sometimes laced with patterns caused by the presence of permafrost.

The Taiga Shield Ecozone experiences considerable variation in daylight over the course of a year. Areas north of the Arctic Circle endure at least one day in which the sun never rises and at least one in which it never sets.

The subarctic climate is characterized by short, cool summers and long, cold winters. Precipitation is low to moderate, averaging 250 to 500 mm a year across much of the ecozone. On the Labrador coast, it ranges up to 800 mm annually. Snow and freshwater ice-cover persist for six to eight months. Dams and diversions have changed seasonal patterns of flow on several rivers in the eastern Taiga Shield.

1. *Yellow Pond Lily*
2. *Cat tail*
3. *Sedge*
4. *Water Parsnip*
5. *Water Smartweed*
6. *Water Horsetail*
7. *Water Arum*
8. *Marsh Five-finger*
9. *Willow*
10. *Ground Juniper*
11. *Kinnikinick*
12. *Fruticose Lichens*
13. *Dwarf Birch*
14. *Goldenrod*
15. *Grass of Parnassus*
16. *Shrubby Cinquefoil*
17. *Sweet Gale*
18. *Green Alder*
19. *Paper Birch*
20. *Black Spruce*
21. *Layering in Black Spruce*
22. *Labrador Tea*
23. *Northern Commandra*
24. *Wild Rose*
25. *Wood Horsetail*
26. *Wild Chives*
27. *Twinflower*
28. *Feathermoss*
29. *Fire-charred log*
30. *Soapberry*
31. *Crowberry*
32. *Cupidberry*
33. *Bearberry*
34. *High-bush Cranberry*
35. *Cotton-grass*
36. *Fireweed*
37. *Tamarack*
38. *Tree Lichens*
39. *Fire Snag*
40. *Trembling Aspen*
41. *White Spruce*
42. *Jack Pine*
43. *Crustose Lichens*
44. *Rock Harlequin*
45. *Fragrant Shield Fern*
46. *Creeping Juniper*
47. *Prickly Saxifrage*
48. *Mountain Cranberry*
49. *Gooseberry*

PLANTS

Cool temperatures, a short growing season, frequent forest fires, and thin, acidic soils covering permafrost are among the many challenges faced by plants in this ecozone. The open, stunted forests of the Taiga Shield are dominated by a few highly adaptable tree species such as Black Spruce and Jack Pine. These forests are mixed with innumerable bogs and other wetlands, scattered stands of Paper Birch and Trembling Aspen, and bare rock outcrops dominated by colourful lichens and ground-hugging shrubs.

Forest fires add to the distinctive mosaic of the Taiga Shield by creating a patchwork quilt of plant communities that vary widely in species composition and age. Although fire often destroys large areas of forest and occasionally threatens human activities or property, it also has a renewing effect on the landscape by triggering new growth, purging forests of insect pests and disease, and increasing the variety of habitats available to wildlife.

Permafrost is another major influence, especially in low areas where the soggy ground or active layer above the permafrost regularly freezes and thaws. As trees grow in these ever-shifting soils, they often tip in random directions, giving the impression of a "drunken forest."

1. *Bald Eagle*
2. *Bonaparte's Gull*
3. *Red-breasted Merganser*
4. *Arctic Tern*
5. *Pacific Loon*
6. *Greater Scaup*
7. *Beaver*
8. *Red-winged Blackbird*
9. *Green-winged Teal*
10. *Muskrat*
11. *Mew Gull*
12. *Yellow Warbler*
13. *Wood Frog*
14. *Common Redpoll*
15. *Northern Red-backed Vole*
16. *Caribou jaw bone and antler*
17. *Snowshoe Hare*
18. *Beaver-gnawed stumps*
19. *White-crowned Sparrow*
20. *Marten*
21. *Bald Eagle nest*
22. *Flicker*
23. *Black Bear*
24. *Wolf*
25. *Dragonfly*
26. *Least Weasel*
27. *Red Squirrel*
28. *Spruce Grouse*
29. *Black Bear scratch marks*
30. *Yellow-rumped Warbler*

WILDLIFE

One of the most spectacular wildlife displays in the Taiga Shield is the explosive return of ducks, loons, geese, and swans during the spring migration. The area's abundant water attracts hundreds of thousands of birds, which come to nest or simply feed and rest before journeying farther north to arctic breeding grounds.

As an ecological crossroads between two very different ecosystems – the boreal and the arctic – the ecozone offers a relatively wide variety of habitats for birds. Lakes, wetlands, and forests are interwoven with open shrublands and sedge meadows more typical of the tundra. The consequent overlap of arctic and boreal bird species gives this area a special richness. At the southern limit of their summer range are such species as the Arctic Tern, while a host of other water birds, including the Common Tern and White-throated Sparrow, reach their northern limit on the Taiga Shield.

Among the mammals of the ecozone are Barren-ground Caribou, which migrate south from the tundra to their winter range in the taiga forest. Close to a million Caribou from the Bathurst, Beverly, and Qaminirjuaq herds in the Northwest Territories, and the Leaf River and George River herds of northern Quebec and Labrador, make this journey each fall and return to calve on the tundra each spring.

Mice, Voles, Shrews, Weasels, Canids, and other carnivores, plus all the tundra dwellers such as the Grizzly Bear and Arctic Fox, make regular visits to the trees of the Taiga Shield. In all, there are about 50 species of mammals inhabiting the ecozone.

The ecozone's waters, meanwhile, are home to Lake Trout, Lake Whitefish, Arctic Grayling, Burbot, and Northern Pike.

1. *Hunting and trapping*
2. *Mining potential*
3. *Hydroelectric potential*

HUMAN ACTIVITIES

The human population of about 340 000 persons is 60% aboriginal, divided into Algonquian-speakers in most of the ecozone and Athapaskan-speakers in the western portion. The population is concentrated in a few permanent settlements, the location of which largely reflects the history of recent colonization.

Coastal settlements were established in the eastern Taiga Shield during the fur trade and whaling eras. The location of more recent communities, including Yellowknife in the Northwest Territories, Uranium City in Saskatchewan, and Churchill Falls and Labrador City in Labrador, reflects the location of ore bodies or hydro-electric potential. Even the largest towns, such as Yellowknife (15 179 persons) and Labrador City (11 390 persons), are surrounded by wilderness. There are few all-weather roads, but they reach every community with at least 1 000 persons. In the Quebec portion of the ecozone, several thousand kilometres of roads for logging, mining, and other uses have been built in recent decades.

The economy combines a small number of industrial activities. Two of Canada's three largest hydro developments are found in the ecozone. The economic importance of mining to the economy of the Taiga Shield is significant. The largest mineral rush in Canadian history started in 1991 following the discovery of diamonds in the Slave Geological Province in the Northwest Territories. Uranium mining is conducted in northern Saskatchewan, gold is extracted near Yellowknife, and iron is mined in Quebec and Labrador. Despite urbanization, subsistence hunting, trapping, and fishing are still practised widely.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A 0H3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

5. LAND OF DWARF TREES

FURTHER READING

Anon. 1990. Northwest Territories Data Book. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-23-2.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto, Ont. ISBN 0-8020-2137-9.

Boden, J.F. and E. Boden, eds. 1991 Canada North of Sixty. McClelland and Stewart Inc. Toronto, Ont. ISBN 0-7710-1581-X.

Bone, R. 1992. The Geography of the Canadian North. Oxford University Press. London ISBN 0-19-540772-5.

Godfrey, W.E. 1986. The Birds of Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-10758-9.

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada. Ottawa. Ont.

Moon, B. 1975. The Canadian Shield. N.S.L. Natural Science of Canada Limited. Toronto, Ont. ISBN 0-9196-4408-2.

Padgham, W.A. 1987. Yellowknife Guidebook – A Guide to the Yellowknife Volcanic Belt and its Bordering Rocks. Indian and Northern Affairs Canada. Yellowknife, N.W.T.

Porsild, A.E. and W.J. Cody. 1980. Vascular Plants of Continental Northwest Territories, Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-00119-5.

Pruitt, W.O. 1983. Wild Harmony – The Cycle of Life in the Northern Forest. Western Producer Prairie Books. Saskatoon, Sask. ISBN 0-88833-101-0.

Renewable Resources. Various dates. NWT Wildlife Sketches. (Brochures on selected wildlife species.) NWT Culture and Communications. Yellowknife, N.W.T.

Walker, M. 1984. Harvesting the Northern Wild. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-10-0.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid, V. Neimanis, John Anderson, Gary Ironside and many others – while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Basteda). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

The text was edited by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

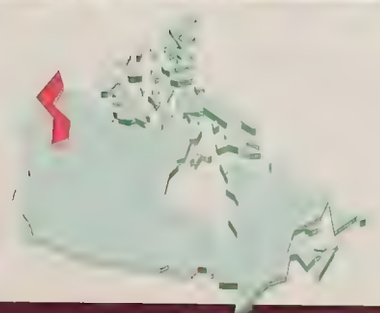
Northern posters are adapted and reproduced by permission from CYGNUS Environmental Consulting, Yellowknife.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



NORTHERN MOUNTAINS

Taiga Cordillera Ecozone

The Taiga Cordillera Ecozone is a land of magnificent beauty. It is a mountain stronghold of towering peaks, untamed rivers slicing their way between sheer rock walls, broad windswept uplands dominated by alpine and arctic shrubs and flowers, plus vast wetlands and spruce-lined valleys that support many kinds of wildlife. This land hosts some of Canada's largest waterfalls, deepest canyons, and wildest rivers.

Straddling the Yukon-Northwest Territories border, this ecozone contains the northernmost arc of the Rocky Mountain chain. To the northwest are expansive wetlands and rolling hills that stretch to the Beaufort coast. Treeless arctic tundra dominates its northern reaches and gives way to a mix of alpine tundra and lowland forests farther south. "Cordillera" refers to the series of mountain ranges and valleys that form this ecozone's rugged interior. Here the mark of forces that create and destroy mountains can be clearly seen in the record of the rocks.

The diverse habitats, from valley bottoms to mountain tops, support a wide range of mammals, including two kinds of caribou and bears. The birds that nest here include a mixture of species typical of the Arctic and Subarctic, as well as eastern and western Canada.

The earliest human inhabitants of this area migrated across the Bering land bridge during the decline of the last ice age about 12 000 years ago. An ice-free corridor paralleling the Mackenzie Mountains allowed early colonization by the Athapaskan ancestors of today's Slavey, Mountain Dene, and Gwich'in peoples. Industrial developments related to this area's rich oil, gas, and mineral reserves are few, and the northwestern rim of the country remains a vast wilderness area.

1. *Talus slopes*
2. *Hoodoos*
3. *Folded mountain*
4. *Braided river channel*
5. *Craggy limestone peaks and ridges*
6. *Butte*
7. *Alluvial fan*
8. *Sedimentary rocks*
9. *Fault*
10. *Cave*
11. *Stone stripes*
12. *Stone polygons*
13. *Brachiopod fossils*
14. *Coral fossils*
15. *Gastropod fossils*

LANDFORMS AND CLIMATE

Much of the Tundra Cordillera Ecozone is characterized by steep, mountainous terrain consisting of a series of sharply etched ridges and narrow valleys. Other features include rolling foothills, upland plateaus, and low-lying basins.

The geological history of this region began about half a billion years ago. At that time, much of the area was a shallow marine platform off the west coast of the ancient protocontinent that later gave rise to North America. Rivers flowing off the protocontinent deposited sand, mud, and gravel on this platform, creating the sandstones, mudstones, and shales that today make up much of the area's abundant sedimentary rocks. Limestone and dolomite, formed from the skeletal debris of marine organisms, are also common.

The original sedimentary rocks started to undergo significant folding and uplifting about 200 million years ago. This occurred as the platform on which they were laid down slowly drifted west, colliding with and overriding other crustal plates in its path. New chains of mountains sprang up in response to these collisions. The most active period of mountain building occurred about 100 million years ago, when local stresses beneath the Earth's crust forced red-hot molten rock toward the surface to produce the igneous rocks visible today.

Since then, these rocks have undergone slow but sure destruction by a variety of erosive forces: glacial ice sheets that engulfed much of the region several times over the last few million years; streams and rivers carved down through the high plateaus and mountains; and the simple action of gravity, which causes mountains to gradually collapse. Some of the most unusual landscapes are, however, now near the Beaufort Sea. These areas escaped glacial scour.

The cyclic freezing and thawing action of permafrost-rich soils enhances these processes of disintegration. The resulting polygon and stripe-like patterns often seen in alpine areas attest to the dynamic state of this ecosystem.

The climate is extremely cold and humid, with long, dark winters and short, cool summers. Precipitation is low to moderate, averaging from 250 to 300 mm a year across much of the ecozone. Snow and freshwater ice-cover persist for six to eight months annually.

1. *Alpine Fir (stunted krummholz in foreground)*
2. *Black Spruce and White Spruce*
3. *Fire Snag*
4. *Larkspur*
5. *Cotton-grass*
6. *Blue-green Willow*
7. *Shrub Birch*
8. *Sedges*
9. *Fruticose Lichens*
10. *Forget-me-not*
11. *Woolly Lousewort*
12. *Arnica*
13. *Hedysarum*
14. *White Camas*
15. *Net-veined Willow*
16. *Purple Mountain Saxifrage*
17. *Crustose Lichens*
18. *Alpine Bearberry*
19. *Mountain Avens*
20. *Yellow Mountain Saxifrage*
21. *Arctic White Heather*
22. *Prickly Saxifrage*

PLANTS

The types of plants in this ecozone and the lushness of their growth are strongly influenced by their position on mountain slopes, which determines the amount of available soil moisture and sunlight. Western slopes often have more luxuriant plant cover than eastern ones, since clouds deposit most of their moisture on western slopes before continuing east. Similarly, northern and southern mountain slopes show pronounced differences in plant growth because of differences in the amount of sunlight they receive. South-facing slopes tend to be warmer and drier, conditions that favour soil nutrient release and plant growth common in more temperate climates. Plants on north-facing slopes typically include species better adapted to cold climates.

Four main vegetation zones are found in this ecozone. Extensive areas of alpine tundra occur on the upland plateaus and highest mountain slopes. Here, scattered among lichens, sedges, and mosses are species that typically possess very large flowers relative to the rest of the plant. Their function is to attract insect pollinators during the short growing season.

Further downslope is the subalpine transition zone, which is dominated by scattered Alpine Fir trees and a dense understory of Willow and Shrub Birch. White and Black Spruce replace firs in the lower parts of this zone. Below the subalpine zone on the lower flanks of the mountains is the montane zone, characterized by spruce-lichen woodlands and flat benches of Lodgepole Pine. Isolated stands of deciduous trees such as Trembling Aspen and Paper Birch are found here, growing in the aftermath of forest fires.

In the lowland zone, sheltered conditions, abundant moisture and relatively well-developed soils promote the growth of dense spruce-feathermoss forests and riverside communities of Balsam Poplar, Willow, and Alder. Marshes and other productive wetlands are also common in this zone, particularly along flat river valleys. Wetlands reach their greatest extent in the Old Crow Flats, a vast plain of wetlands and lakes. Many of the lakes take on a natural square like form.

1. *Dall's Sheep*
2. *Woodland Caribou*
3. *White-winged Crossbill*
4. *Lincoln's Sparrow*
5. *Varied Thrush*
6. *White-tailed Ptarmigan*
7. *Wolverine*
8. *American Kestrel*
9. *Grizzly Bear*
10. *Golden Eagle*
11. *Golden Eagle nest*
12. *Mountain Goat*
13. *Horned Lark*
14. *Townsend's Solitaire*
15. *Water Pipit*
16. *American Pika*
17. *Arctic Ground Squirrel*
18. *Hoary Marmot*
19. *Violet-green Swallow*

WILDLIFE

Because of its diversity of habitats, from dense spruce forests to arctic tundra, from alpine mountain peaks to marshy flats, the Taiga Cordillera Ecozone includes a wide array of wildlife species representative of both arctic and temperate climates.

Mammals most common in alpine terrain include the American Pika, Hoary Marmot, Grizzly Bear, and Dall's Sheep. Mountain Goats, which are not really goats at all but members of the antelope family, are found on mountains in southern regions. During the spring and summer, alpine habitats are populated with several tundra-adapted birds, such as the White-tailed Ptarmigan, Horned Lark, and Water Pipit.

Woodland Caribou, Lynx, Marten, and Black Bear are common mammals of the lower forested habitats. Common birds in this zone include the White-winged Crossbill, Varied Thrush, and Gray Jay. River and wetland habitats support several waterfowl species, including Canvasback, Common Golden-eye, Mallard, and the rare Trumpeter Swan.

The Yukon's Old Crow Flats represent only a small part of this ecozone, yet it is a large and notable wetland that has received international recognition. Swans, Canada Geese, and other species nest or stage here each year in the tens of thousands. Another wildlife spectacle is the annual migration of the Porcupine Barren-ground Caribou, a herd of more than 150 000 animals that winters in the northwestern woodlands.

Evidence of this ecozone's wild and unspoiled character is Canada's largest concentration of Wolverines, a species that has been called a true wilderness creature. Like other members of the weasel family, this solitary nomad is curious, bold, and strong. It will fiercely defend its food against the attack of animals many times its size. Renowned for evading traps and robbing the most carefully protected caches of food, the Wolverine plays a leading role in the camp-fire tales of this region.

1. *Subsistence hunting*
2. *Tourism*

HUMAN ACTIVITIES

The Taiga Cordillera is a sparsely populated ecozone and home to the Vuntut Gwich'in people. The total population consists of 300 people, 256 of whom reside in the settlement of Old Crow, the Yukon's most northerly community. Much of the area remains essentially untouched wilderness. Subsistence hunting, trapping, and fishing dominate much of the local economy. The Northern Yukon Park and the area's spectacular scenery makes this ecozone attractive to tourists from around the world.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

6. NORTHERN MOUNTAINS

FURTHER READING

Anon. 1990. Northwest Territories Data Book. Outcrop. Yellowknife, N.W.T.ISBN 0-919315-23-2.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto, Ont. ISBN 0-8020-2137-9.

Boden, J.F. and E. Boden, eds. 1991. Canada North of Sixty. McClelland and Stewart Inc. Toronto, Ont. ISBN 0-7710-1581-X

Bone, R. 1992. The Geography of the Canadian North. Oxford University Press, London. ISBN 0-19-540772-5.

Burt, P. 1991. Barrenland Beauties. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-25-9.

Douglas, R.J.W., ed. 1970. Geology and Economic Minerals of Canada – Economic Geology Report No. 1. Geological Survey of Canada. Ottawa. Ont.

Godfrey, W.E. 1986. The Birds of Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-10758-9.

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada. Ottawa, Ont.

Parks Canada. 1984. Nahanni National Park Reserve Resource Description and Analysis. Natural Resource Conservation Section. Winnipeg, Man.

Porsild, A.E. and W.J. Cody. 1980. Vascular Plants of Continental Northwest Territories, Canada. National Museums of Canada. Ottawa, Ont. ISBN 0-660-00119-5.

Renewable Resources. Various dates. NWT Wildlife Sketches. (Brochures on selected wildlife species.) NWT Culture and Communications. Yellowknife, N.W.T.

Scotter, G.W., L.N. Carbyn, W.P. Neily, and J.D. Henry. 1985. Birds of Nahanni National Park. Saskatchewan Natural History Society. Regina, Sask.

Walker, M. 1984. Harvesting the Northern Wild. Outcrop. Yellowknife, N.W.T. ISBN 0-919315-10-0.

Wiken, E. et al. 1981. The Northern Yukon: An Ecological Land Survey. Environment Canada: Ecological Land Classification Series, No. 6. Vancouver, B.C.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid, V. Neimanis, John Anderson, Gary Ironside and many others – while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

The text was edited by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

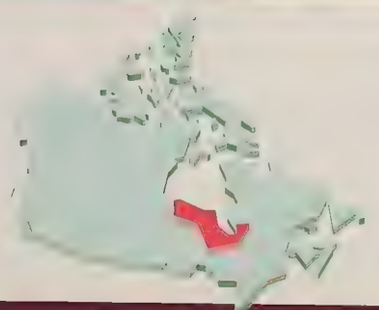
Northern posters are adapted and reproduced by permission from CYGNUS Environmental Consulting, Yellowknife

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

Environment Canada Environnement Canada



THE WETLANDS

Hudson Plains Ecozone

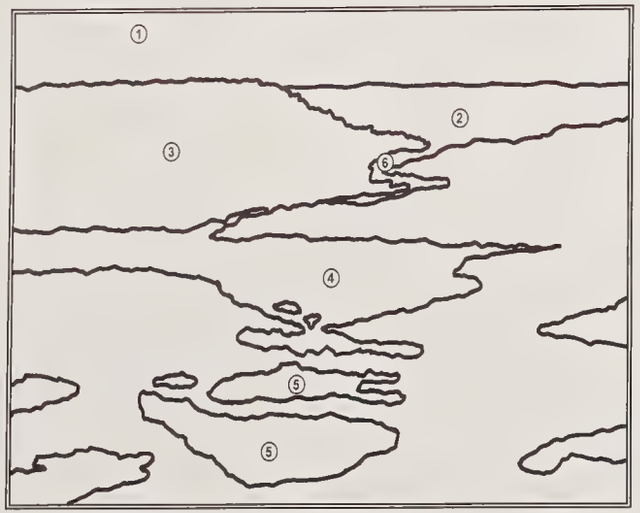
Canada has approximately 25% of the world's wetlands. The Hudson Plains alone embrace the bulk of this figure. Some say it is the largest coextensive wetland on the planet.

For the early explorers and fur traders, the Hudson Plains Ecozone acted as a gateway to the interior of central Canada. The area has been associated with the early wars between England and France and with the harshness of pioneering days. Its sense of prominence is largely tied to historical events. Today, it gains much of its recognition from the profile of Polar Bear Provincial Park.

Most of the ecozone lies in northern Ontario but it reaches into Manitoba and, to a lesser extent, Quebec. It occupies about a quarter of Ontario and 4% of Canada, covering 369 000 square kilometres of land and 11 800 square kilometres of water. About 10 000 people live there, representing just 0.04% of Canada's population. The density is 2.7 people per 100 square kilometres, whereas the Boreal Shield to the south has 155 per 100 square kilometres. Only the Taiga Cordillera and the Arctic Cordillera ecozones have fewer people. Fewer than 10% reside in urban areas.

Overall, the Hudson Plain is poorly drained, flat and dominated by extensive wetlands. As though sculpted by an artist, the greenery of the plains is marked by a series of arcing and evenly-spaced white lines. These belts of raised beaches show the steady progress of rebounding from the weight of the ice sheet that covered the area thousands of years ago. They present striking patterns of successive ridges alternating with bogs and swamps. A cold and long subarctic winter prevails for much of the year. Rising temperatures and melting ice in the summer make fog common on the coast. The short cool summers provide a brief window for the thousands of migratory birds that make their home on the plains.

The wetlands and fog brought early notoriety to this area. For the people in the coastal fortifications established by the Hudson's Bay Company, the long bitter winters were considered generally insufferable. Summers brought little relief. They summarized the warm season by calling the place an insect-infested landscape of bog and fog.



1. *Summer sky*
2. *Ocean and sea ice*
3. *Beach ridges and wetlands*
4. *Small lake/ponds*
5. *Bog/fen*
6. *Coastal river*

LANDFORMS AND CLIMATE

Few areas in Canada are comprised of extensive plains. Only parts of the central prairies and Northwest Territories are comparable. Churchill in northern Manitoba represents the approximate western edge of the Hudson Plain and it extends about 1 300 kilometres east to just beyond Fort Rupert in Quebec. To the north, the plains shoulder the waters of Hudson Bay and James Bay. From this coastline, the plain arcs south for 200 to 300 kilometres to Gillam, Mba., and close to Kapuskasing, Ont. Rising slowly from sea level, this flat lowland reaches an average elevation of just 120 metres.

The mineral soils that cover much of the area are finely-textured silt and clay deposited by both marine and glacial processes. Outcrops of the underlying sandstone and shale are rare. During the last ice age, the weight of the glaciers depressed the Hudson Bay region and the ocean waters later flooded areas up to 300 kilometres inland from the current coastline. During the retreat of the massive continental ice sheets, drainage into Hudson Bay was blocked and expansive lakes – Agassiz and Ojibway – were formed along the margins of the retreating ice. Seven thousand years later, the area is still rising. This has led to the development of the striking stripe-like features marking a succession of beach ridges. The lines, often composed of sandy material, radiate like ripples from the present-day coast, marking different stages of the rebound.

Since glaciation, the flat terrain, impervious soil and poor drainage have promoted the development of wetlands throughout the plains. Web-like or polygon patterns in organic soils are typical of northern wetlands. The widespread permafrost and ground ice also contribute to poor surface drainage and the slow rate of decay. Frozen organic soils predominate, while partly decayed organic soils are more common in southern parts and moderately weathered mineral soils are restricted to the warmer and drier locations, such as the beach ridges. Rivers and streams generally flow north-easterly to the coast and most have headwaters in the Boreal Shield ecozone to the south.

Major rivers include the Nelson and Hayes in Manitoba, the Severn, Winisk, Albany and Abittibi in Ontario, and the Eastmain and La Grande in Quebec. These rivers follow fairly long and straight routes. Flow varies dramatically over the course of the year and is virtually non-existent between September and January. In late summer, the channels may contain pools and stretches of trapped water, and spring floods can push water levels 10 to 15 metres higher than usual.

The narrow river valleys often provide the only areas of marked relief from the plains. These major rivers are fed by streams with gentle gradients and sluggish flows. Small, shallow ponds and lakes are numerous and dot the landscape in a leopard-like pattern. Ocean tides are weak and the currents flow counterclockwise around the bay.

Hudson Bay moderates the temperature of the lowlands during summer but the effect diminishes in winter when the bay is ice-covered. Cold, dry arctic air typically lingers over the area throughout winter. With little marked relief, the temperature and precipitation correlate closely with latitude.

Temperatures throughout the year tend to be colder near the coast and warmer inland. Summers are cool and brief. The average mean daily temperature in July ranges from 12°C to 16°C and in January it hovers around -25°C to -23°C. Frost free periods are shortest (about 70 days) on the coast and longest (80 days) along the southern margin. The average growing season ranges from 500 to 1 000 growing degree days above 5°C. Average annual precipitation is approximately 500 mm to 700 mm per year, and is lowest in the north. Rainfall peaks in the month of July at about 100 mm. Of this precipitation, snow accounts for very little; snowfall may be in the 2 000 mm range, half that of the Great Lakes area. The mean maximum depth of snow averages less than 1 000 mm. The spring break-up on major rivers tends to occur in late April or early May and ice jams can raise river levels by 7 to 10 metres.

1. *Black Spruce*
2. *Spruce bog*
3. *Dead Black Spruce*
4. *Sedges, mosses, lichens*
5. *Rushes, Horsetail*

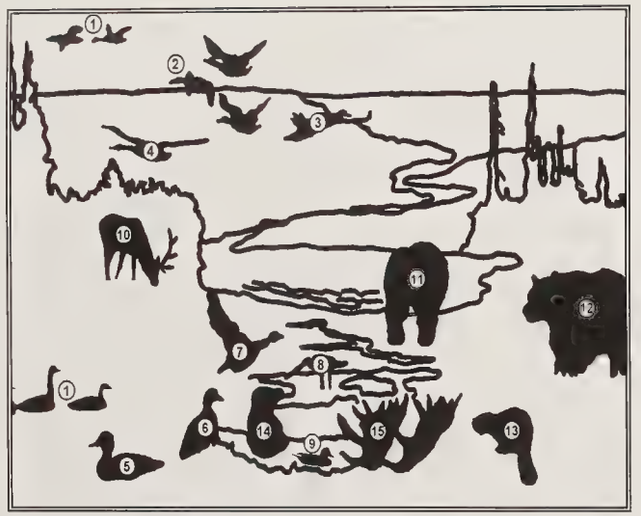
PLANTS

Plant species in the Hudson Plain follow latitudinal and soil drainage patterns. Where the boreal forests and the tundra merge in the lowlands, vegetation resembles that of the arctic tundra and to a larger degree the taiga transitional forests. Trees here are few and far between.

The treeless areas extend about 30 kilometres south from the coast but stands of trees can penetrate further north where sites are sheltered or better drainage and deeper soil are available. Arctic tundra can be divided into low and high types. This area is largely representative of the low arctic. Wet areas are dominated by tussocks of sedge, Cottongrass and Sphagnum Moss. Dwarf Birch and Willow shrubs are also common. On drier sites, shrubby and the low-lying Lapland Rosebay, Crowberry, Blueberry and Cloudberry take hold. Herbs such as Arctic Aven, Purple and Prickly Saxifrage, and Lousewart are also found.

South of the tundra is a transition zone known as the taiga. In the lowlands, it can be fairly narrow or up to tens of kilometres wide. Open stands of White Spruce dominate drier areas, while low stands of Willow, Black Spruce and Tamarack are common on wetter and more exposed sites

The low taiga areas are similar to the high boreal forests. The basic components are boreal in nature but growth and productivity are low and forest stands tend to be more open. White Spruce, Black Spruce, Larch, Balsam and Poplar are the most common trees and Willow and Dwarf Birch are typical shrubs. White spruce in association with Reindeer Moss, Caribou Lichen and Crowberry cover the better-drained and elevated areas.



1 *Canada Geese*
2 *Lesser Snow Geese*
3. *Northern Pintail*
4 *Tundra Swan*
5. *Atlantic Brant*
6. *Willow Ptarmigan*
7. *Mallard*
8. *Semipalmated Sandpiper*
9. *Green-winged Teal*
10. *Woodland Caribou*
11. *Polar Bear*
12. *Black Bear*
13. *Beaver*
14. *Otter*
15. *Moose antler*

WILDLIFE

Summer on the Hudson Plain sees the greatest numbers and variety of wildlife. It is associated with the nesting and rearing stages of millions of Snow Geese, which migrate to Canadian wetlands from areas as far south as the Gulf of Mexico. Other migratory bird species returning to these lowlands include Canada Goose, Black Duck, Oldsquaw, King Eider, Pintail and Whistling Swan. While fewer in number, upland bird species such as Willow Ptarmigan, Spruce Grouse, Snow Owl, and Raven can also be found and are among the few year-round residents. Osprey, Gyrfalcon, Peregrine Falcon are birds of prey reported in the area. Small mammals include Muskrat, Ermine, Weasel, Marten and Wolverine. Large mammals have traditionally been more abundant in the interior Shield country to the south, but Woodland Caribou, Moose, Black Bear and Timber Wolves are not unknown. Other species include the Canada Lynx, Snowshoe Hare, and Striped Skunk.

Closer to the coast are such species as Polar Bear, which ventures onto the sea ice in winter, and Arctic Fox. Marine mammals include Walrus, Bearded, Ringed and Harbour seals, along with Beluga Whale and the rare Bowhead whales.

Famous in many arctic areas are the clouds of insects. In summer the abundant and poorly drained wetlands provide the ideal breeding ground for massive numbers of mosquitoes and other biting insects. An area of one hectare can produce more than 10 000 000 mosquitoes. Black Fly and No-see-um are other pests to humans and wildlife.

The common fish found in inland streams and lakes are Brook Trout, Northern Pike and Walleye. Some, including the Brook Trout, are migratory, wintering in the interior lakes and summering in the river mouths and estuaries of Hudson Bay.

1. *Tourism*
2. *Hunting, trapping and fishing*

HUMAN ACTIVITIES

Human activities have strong historical roots in the Hudson Plain. The ill-fated expedition of Henry Hudson, who was set adrift by his mutinous crew in 1611, left the legacy for most of the names on today's maps. Later, interest in fur drew other English and French explorers to this area. In the late 1600s, the Hudson's Bay Company erected a series of forts along the bay at the Albany, Rupert, Moose and Hayes rivers and, later in the early 1700s, on the Churchill River. These posts were the early gateways to the riches of central Ontario, Manitoba, Saskatchewan and the Northwest Territories.

To people that lived in the forts, the surrounding lowlands were dubbed the "land of bog and fog" or the "insect-infested swamp." Further to the south, the lowlands were bordered by an area of "little else than rocks with innumerable lakes " They regarded the area as a "food desert" because many of the initial settlers found food supplies difficult to find. By European standards, it was a harsh and testing environment.

In many respects, the fur trade brought European and aboriginal cultures together and for years it was a prosperous venture. Unfortunately, fierce competition for furs between the North West Company from lower Canada and the Hudson's Bay Company eventually strained the native economy, affecting subsistence and commercial activities.

Today, the settlements of Churchill and Moosonee are perhaps the most recognized in the ecozone; each lies at the end of a railway line. Fort George, Eastmain, Fort Albany, Attawapiskat, Lake River, Winisk, Fort Severn and Shamattawa are less well known. Except for these largely coastal villages, the area is almost unpopulated, home to only 10 000 residents. While the ecozone is ecologically diverse, it is not well-endowed with timber and minerals. Instead, tourism, fishing, hunting, and trapping provide the main economic base. Polar Bear Provincial Park draws many tourists. The varied wildlife, contrasting landscapes, ocean coasts and scenic rivers of the area have become popular attractions.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3 Southern Arctic	*8 Boreal Plains*	*13. Prairies*	*18 Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

7. THE WETLANDS

FURTHER READING

Brown, Craig (editor).1987. The illustrated history of Canada. Lester & Orpen Dennys Ltd. Toronto, Ontario M5T 1C1. 574 pages. ISBN 0-88619-147-5.

Fulton, R. J. (coordinator). 1989. Quaternary geology of the Canadian Shield. Chapter 3 in Quaternary geology of Canada and Greenland. Geological Survey of Canada, Ottawa, Ontario K1A OE8. pages 177-318. ISBN 0-660-13114-5.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Hutton, C. L. A. and W. A. Black. 1975. Ontario arctic watershed. Map folio No. 2. Lands Directorate. Environment Canada. Ottawa, Ontario K1A OS9. 107 pages.

*Ministry of Natural Resources. 1977. Polar Bear Provincial Park: background information. Technical information report. Ministry of Natural Resources, Queen*s Park. Toronto, Ontario. 54 pages.*

Mortsch, Linda (editor). 1990. Eastern Canadian boreal and sub-arctic wetlands: a resource document. Climatological studies number 42. Atmospheric Environment Service. Toronto, Ontario. 169 pages. ISBN 0-662-18473-4.

Wickware, G. M. and C. D. A. Rubec. 1989. Ecoregions of Ontario. Ecological land classification series No. 26. Lands Directorate, Environment Canada. Ottawa, Ontario. K1A OH3. 37 pages

Wiken, E. B. 1986. Terrestrial ecozones of Canada. Ecological Land classification series. No 19. Lands Directorate, Environment Canada. Ottawa, Ontario. K1A OH3. 26 pages.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by William J. Johnson of Fine Art Studio, London, Ont.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid and V. Neimanis – and many others. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was carried out by West Hawk Associates in Ottawa

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

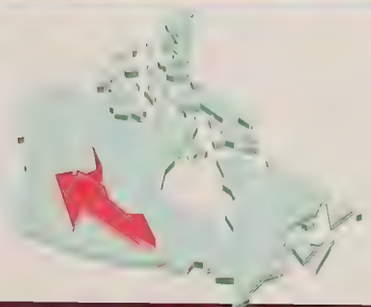
Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



BOREAL HEARTLAND

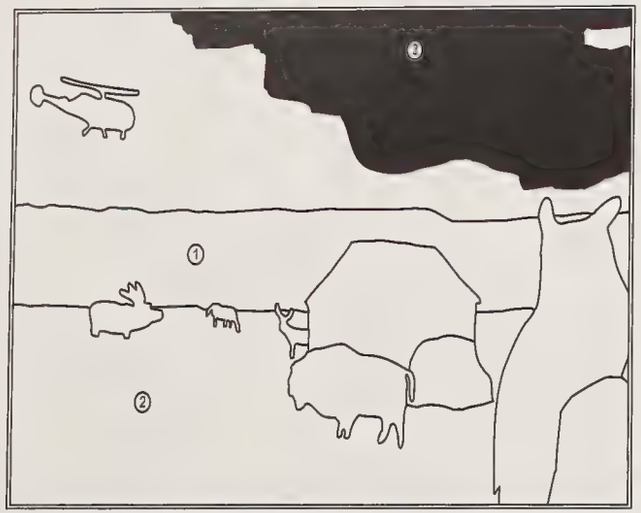
Boreal Plains Ecozone

The Boreal Plains Ecozone is part of the flat Interior Plains of Canada, a northern extension of the Great Plains of North America. The subdued relief consists of low-lying valleys and plains stretching across the mid portions of Manitoba and Saskatchewan, and continuing through almost two-thirds of Alberta. It covers 650 000 square kilometres, an area larger than the Yukon. The majority of the surface waters are part of three watersheds: those of the Saskatchewan River, the Beaver River, and Peace, Athabasca, and Slave rivers' watershed.

Timber covers 84% of the Boreal Plains and forestry is the primary industry. Less than 20% of the land area is devoted to agriculture. However, precipitation and surface and groundwater sources are more than adequate to meet agricultural demand.

The ecozone has traditionally been viewed by some as the next untapped resource frontier. The ecozone's relative remoteness and absence of large population centres has resulted in little comprehensive scientific study.

To explore, produce and deliver the potential oil and gas products believed to be buried under the ecozone, vast road, railway and pipeline networks have been developed and thousands of kilometres of seismic exploration lines cut through the forests, providing access to previously remote areas.



1. *Low hills*
2. *Plains*
3. *Clouds*

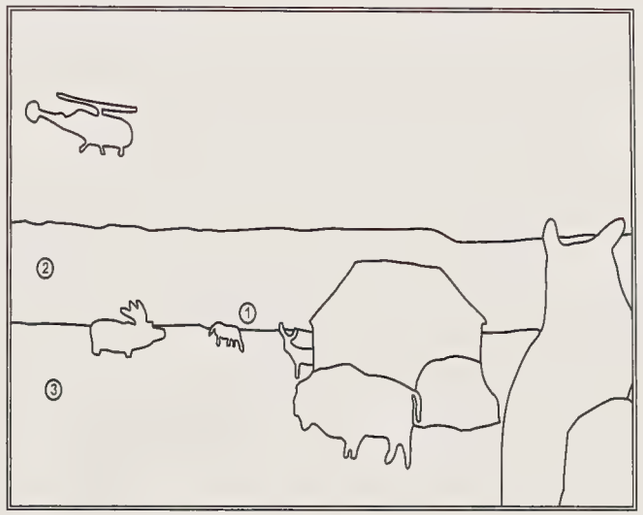
LANDFORMS AND CLIMATE

Multiple ice ages had a pronounced effect on the Boreal Plains. Continental glaciation flattened the landscape and left behind a variety of glacial deposits consisting almost entirely of undulating and level to gently rolling plains dotted with small lakes. Following glacial retreat 8 000 to 11 000 years ago, larger lakes developed from glacial meltwater, creating extensive deltas and dunes. Lake Winnipegosis, for example, is a remnant of the bygone Lake Agassiz.

Underlying these landforms are horizontal layers of sedimentary bedrock laid down millions of years ago during the Cretaceous and Tertiary periods.

Most of the major rivers have their origin in the Rockies. These rivers flow east across the ecozone and are the products of rainfall, snowmelt and glacial runoff at their headwaters.

The climate of the Boreal Plains Ecozone is determined by its location in the heart of North America. The Rocky Mountains to the west block moisture-bearing winds from the Pacific The result is short, warm summers and long, cold winters. The annual precipitation, approximately 450 mm, is greater than the evaporation rate, resulting in surplus moisture of up to 100 mm near the southern edge of the ecozone and up to 300 mm in the northern and foothills regions.



1. *Poplar forest*
2. *Pine forest*
3. *Mixed Prairie grasses*

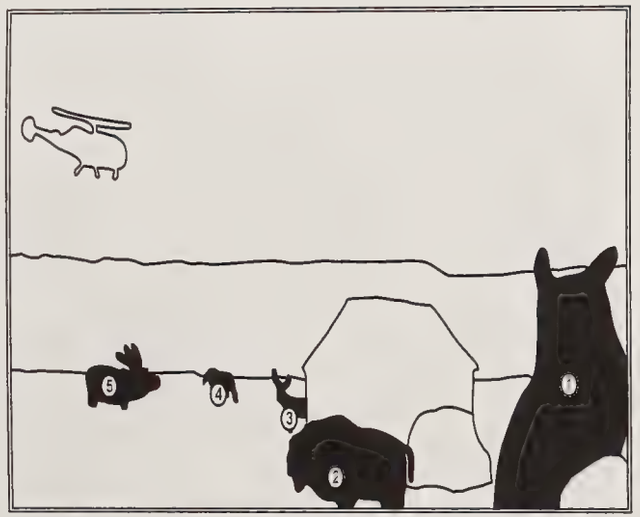
PLANTS

Nearly half of the Boreal Plains is occupied by productive forest land. The pace of logging increased after 1956 when the first pulp mill was established in Alberta. Others followed in Saskatchewan in 1968 and Manitoba in 1971. Technology improvements during the 1980s led to a 20-fold increase in the harvesting of previously little-valued Aspen. Between 1951 to 1991, the amount of forest logged increased by 82%. Pressure is mounting to find methods to log without causing irreversible damage to the environment

Today, most of the ecozone is associated with the boreal forest. It is composed of White and Black Spruce, Balsam Fir, Jack Pine and Tamarack in some peatlands. Of the broadleaf trees, Aspen and Poplar are the most common, and Birch exists in some areas. Fire, the most powerful influence on the forest, determines distribution and growth rates. In a typical year, more than one million hectares burn, despite increasingly effective fire suppression and prevention efforts. In particularly bad fire years, such as 1989 and 1995, huge areas were devastated by fire.

The forests are also affected by native insect pests and disease Unchecked outbreaks of Spruce Budworm have killed extensive tracts of spruce and fir forests. Other insects, such as the Tent Caterpillar, have defoliated and damaged Trembling Aspen stands,most notably in 1988. Secondary organisms, including other insects and fungi, often attack and kill trees weakened by defoliation or drought

The characteristic soils are grey Luvisols, developed in loamy conditions under a forest canopy. Lakes and wetland areas, such as sloughs and marshes, are areas of rich vegetation. In poorly-drained areas, extensive bogs have developed.



1. *Great Horned Owl*
2. *Bison*
3. *Whitetail Deer*
4. *Horse*
5. *Elk*

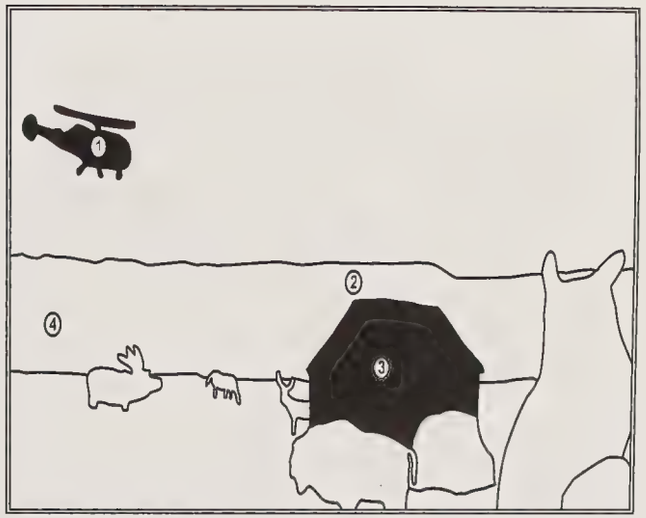
WILDLIFE

Human activities have divided the original ecosystems of the Boreal Plains into fragments. As a result, most wildlife populations and their habitats have greatly diminished. Although logging is believed to be partly responsible for an increase in Moose populations since 1955, forest habitat has been lost steadily to timber harvesting. Fish in major rivers and lakes must now face subsistence and commercial fisheries and an array of recreational activities. Within these aquatic ecosystems, there is concern for high-value fish stocks, particularly Walleye and Sauger, which are sought after by both commercial and recreational fishers. Habitats also suffer from increasing water consumption and toxic farm run-off.

Wetlands form an essential part of wildlife habitat, often surviving forest fires to provide refuge and initial browsing lands for wildlife. River levees also provide productive and sheltered areas, especially during harsh winters. Floodplains and associated marshes form unique waterfowl and Muskrat habitat. Bogs, with their ground and tree lichens, are the main habitat for Woodland Caribou.

The most prominent local species include Timber Wolf, Black Bear, Moose, Woodland Caribou, Mule Deer, Elk, and Beaver. Typical bird species are Gray Jay, Common Loon, White-tailed Sparrow, American Redstart, Canada Warbler and Ovenbird. Game birds found in the region include species of grouse, geese, ducks and ptarmigan. The ecozone's lakes and streams teem with Walleye, Lake Whitefish, Northern Pike, Burbot, Perch, and scattered populations of Lake Trout. Little is known of the insects and arthropod communities.

At least four vertebrate species have disappeared from the area: the Plains Grizzly, Swift Fox, Black-footed Ferret, and Greater Prairie Chicken. Peregrine Falcon (anatum), Mountain Plover, Eskimo Curlew, Piping Plover, and Whooping Crane are endangered, according to the Committee on the Status of Endangered Wildlife in Canada. Threatened species include the Borrowing Owl and Ferruginous Hawk.



1. *Exploration*
2. *Potential oil development*
3. *Farming/ranching*
4. *Forestry*

HUMAN ACTIVITIES

The Boreal Plains entered the history books as a gateway to the great northwest interior of North America. Trading companies established posts along the major rivers at such sites as The Pas and Cumberland House. But the most significant impact on the ecozone was the fur trade. Bison was hunted, first for its meat, which was consumed by fur traders in the 1780s, and then for its hides, which were sold to the North American fashion industry. Thousands of bison were killed each year, leading to the virtual elimination of free-roaming bison by the 1880s.

Development accelerated greatly after 1870, when the Hudson's Bay Company surrendered its charter and sold Rupert's Land, which included the entire Boreal Plains Ecozone, to Canada. As a means of securing the area from potential expansion of the United States, Canada encouraged land development. Much of the arable land was occupied in the years following the completion of the transcontinental railway in 1885, which also introduced coal mining. With the settlement of the prairies came demand for lumber. Nearly half the ecozone is occupied by productive forests. Logging was concentrated in the southern fringes and, by 1900, large sawmills were in operation.

Demand for petroleum products early in the 20th century led to the discovery of the substantial oil and gas reserves in Alberta, where they have been a focal point of the economy for the last 50 years. In Manitoba and Saskatchewan, meanwhile, several hydro-electric power plants were built.

Today, only about 700 000 people, many of them relatively young, live in the ecozone. Despite rapid urban development over the past two decades, just 40% live in major cities. Most municipalities are relatively small compared with those of the Prairie Ecozone.

The most recent major development is the increased use of forests. Between 1951 and 1991, forest harvests increased by 82%. Agriculture has also become a more visible influence. Farmland has increased by 8% over the last 20 years, but still occupies less than 10% of the Boreal Plains. Agricultural activities are dominated by wheat, pasture and rangeland.

The economic structure of the ecozone reflects a relatively high dependence on the service sector, which employs 65% of the labour force, and the primary industries. Over the past century, much of the ecozone has been put to use harvesting natural resources. Forestry predominates, along with agriculture, oil and gas development, hydro-electric power generation, fisheries and mining. The First Nations of the ecozone are tied tightly to traditional places of spiritual significance and ancient burial grounds. They use the ecozone's forests as both their home and workplace. Wildlife is particularly valuable to those who rely on hunting, trapping, and fishing as a primary source of food.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1.
Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

8. BOREAL HEARTLAND

FURTHER READING

Alberta Environment. 1994. Alberta's state of the environment comprehensive report. Edmonton: Alberta Environment, Alberta Environmental Protection. ISBN 0-7732-1412-7.

Cox, K.W. 1993. Wetlands, a celebration of life. Issues Paper No. 1993-1. Ottawa: North American Wetlands Conservation Council (Canada). ISBN 0-6622-0419-0.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Hengeveld, H. 1995. Understanding Atmospheric Change. A State of the Environment Report. Ottawa: Environment Canada. ISBN 0-6622-3098-6.

Manitoba Environment. 1995. State of the environment report for Manitoba. Winnipeg. ISBN 0-7711-1452-4.

Natural Resources Canada. 1995. The state of Canada's forests. Ottawa: Natural Resources Canada, Canadian Forest Service.

Saskatchewan Environment and Resource Management. 1995. Saskatchewan's state of the environment report. The Boreal Plains ecozone: a forest community. Regina: Saskatchewan Environment and Resource Management.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Serge Bedard of Gatineau, Quebec.

Most of the text was written by Environment Canada staff – Ed Wiken, V. Neimanis, Harry Hirvonen, John Reid and many others. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

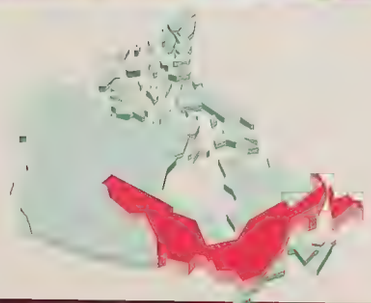
For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

CANADIAN PLAINS RESEARCH CENTER

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



SHIELD COUNTRY

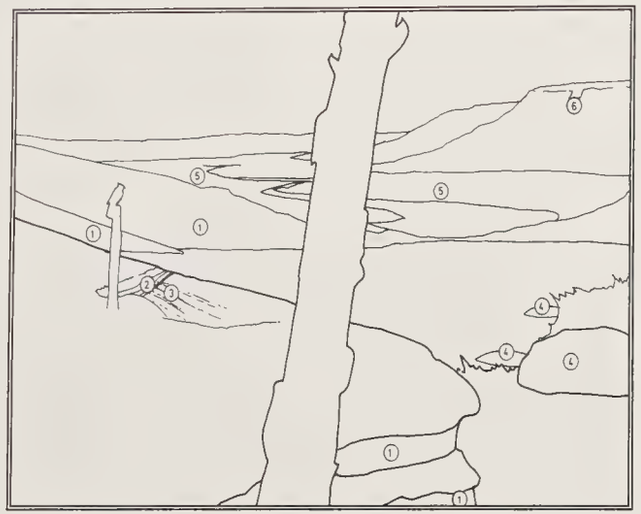
Boreal Shield Ecozone

For generations, the blue lakes and rocky shores of the Canadian Shield have shaped our national identity and psyche. This raw and rolling landscape has left its imprint on some of Canada's best literature, art and drama. Almost two thirds of the country lies on Shield rock. Canada's largest ecosystem, the boreal forest, forms a continuous belt from the east coast to the Rockies. Scientists call the area where the Canadian Shield and the boreal forest overlap the Boreal Shield, the largest of Canada's 15 terrestrial ecozones.

Stretching 3 800 kilometres from Newfoundland to Alberta, the Boreal Shield includes parts of six provinces, covers more than 1.8 million square kilometres, and encompasses almost 20% of Canada's land mass and 10% of its fresh water. Some of Canada's largest rivers have their headwaters in the Boreal Shield, including the Nelson, Churchill, Rupert and St. Lawrence. Huge bodies of freshwater, including lakes Winnipeg, Superior and Huron, lie along its borders. Within it are countless other lakes, some big, such as Lake Nipigon and Lac St. Jean, others so small they remain nameless to this day.

More than just bedrock and bush, the Boreal Shield is home to animals renowned as emblems of Canada's north woods: the Beaver, Moose, Woodland Caribou, Wolf and Black Bear. This well-watered land also provides habitat for migratory ducks and geese drawn here each spring by the thousand.

The original inhabitants of this land – the Beothuk, Algonquians, and Iroquois – abided by its complex cycles and the movements of its animals. By the late 1700s, the area's rich fur, timber and mineral resources had attracted the interest of Europeans. Two hundred years later, frontier resources still form the backbone of the Boreal Shield's economy. While the footprint of industrial development remains relatively small, far-sighted management practices will be needed to sustain the Shield's resources for the enjoyment of future generations.



1. *Canadian Shield Rock*
2. *Quartz vein*
3. *Glacial striations*
4. *Erratic*
5. *Fen-bog complex*
6. *Rocky hills and morainal debris*

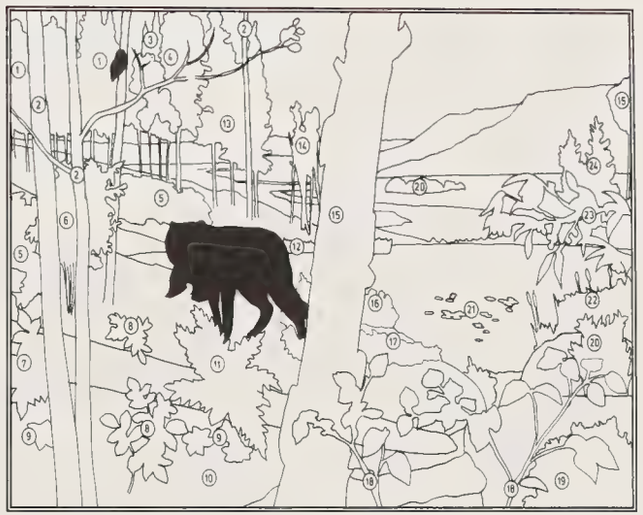
LANDFORMS AND CLIMATE

Canadian Shield rock forms the nucleus of the North American continent. Other geological structures assumed positions around or on top of the Shield millions of years after it was formed. The Rockies are relative newcomers on the geological stage, having risen a mere 60 million years ago. Most Shield rocks were formed well over a billion years earlier, during the very first chapter of the planet's history known as the Precambrian era.

What once may have been a towering mountain chain is today a massive rolling plain of ancient bedrock. During the late Precambrian era, violent spasms in the Earth's crust warped, folded and faulted the Shield. The foundation of much of the ecozone is now metamorphic gneiss, a highly banded rock formed by intense pressure and heat. Many of the minerals that contribute to the Boreal Shield's economy may have formed during these geologically turbulent times.

During the last ice age that ended 10 000 years ago, the advance of glaciers repeatedly plucked and scoured the Shield, carving striations in the bedrock and carrying large boulders many kilometres. In retreat, glaciers blanketed much of the landscape with gravel, sand and other glacial deposits. The many poorly drained depressions left behind, as well as natural faults in the bedrock, now form the millions of lakes, ponds and wetlands that give this ecozone its distinctive character and charm.

The climate of the Boreal Shield is generally continental with long cold winters and short warm summers. Cold air masses over Hudson Bay bring relatively high levels of precipitation to much of the area, from 400 mm in the west to 1 000 mm in the east. The average midwinter temperature is -15°C, while in midsummer it hovers around 17°C. The typical year sees between 60 and 100 frost-free days. Regions bordering the Great Lakes and the Atlantic tend to be warmer in winter and cooler in summer thanks to the moderating influence of large water bodies.



1. *Jack Pine*
2. *Trembling Aspen*
3. *Balsam Fir*
4. *Black Ash*
5. *Mountain Maple*
6. *High Bush-cranberry*
7. *Baneberry*
8. *Wild Sarsaparilla*
9. *Bunchberry*
10. *Moss*
11. *Shield Fern*
12. *Sedge*
13. *White Spruce*
14. *Black Spruce*
15. *White Birch*
16. *Goldenrod*
17. *Blueberry*
18. *Speckled Alder*
19. *Labrador Tea*
20. *Willow*
21. *Water Lilies*
22. *Cattails*
23. *Pin Cherry*
24. *Tamarack*

PLANTS

Cool temperatures, a short growing season, frequent forest fires, and acidic soils challenge plant life in the ecozone. In spite of this, almost 88% of the area is forested by a few highly adaptable trees, such as BlackSpruce, White Spruce, Jack Pine and Balsam Fir. Black Spruce, the most common species, yields high-quality wood pulp and is a prime species for Canada's large paper industry. Further south are broadleaf trees such as Paper Birch, Trembling Aspen and Poplar, and conifers such as Balsam and White, Red and Jack Pine. In southeastern parts of the ecozone, species characteristic of more temperate climates, including Yellow Birch, Sugar Maple, Black Ash and eastern White Cedar, are common.

Throughout the Boreal Shield, these forests are mixed with innumerable bogs, marshes and other wetlands. Covering nearly 20% of the ecozone, these wetlands are among its most diverse and biologically productive ecosystems. Some larger wetlands in southern regions have been converted into commercial berry farms, which produce large volumes of cranberries and blueberries for markets around the world.

Where the scouring effects of glaciation were intense, bare rock outcrops predominate, dotted by colourful arrays of lichen and ground-hugging shrubs.

Forest fires add to the distinctive mosaic of the Boreal Shield by leaving a patchwork quilt of plant life varying in species composition and age. Although fire often destroys large tracts of forest and occasionally threatens human activities or property, it also renews the landscape by triggering new growth, purging old forests of insect pests and disease, and increasing the variety of habitats available to wildlife.

1. *Boreal Owl*
2. *Evening Grosbeak*
3. *Fisher*
4. *Woodland Caribou*
5. *Blue Jay*
6. *Wolf*
7. *Ruffed Grouse*
8. *Bear claw marks*
9. *Pileated Woodpecker*
10. *Moose*
11. *Great Blue Heron*
12. *Beaver dam*
13. *Ring-necked Duck*
14. *Bufflehead*
15. *Beaver*
16. *American Black Ducks*
17. *Striped Skunk*
18. *Muskrat*
19. *Beaver lodge*
20. *Wood Duck*
21. *White-throated Sparrow*
22. *Broad-winged Hawk*

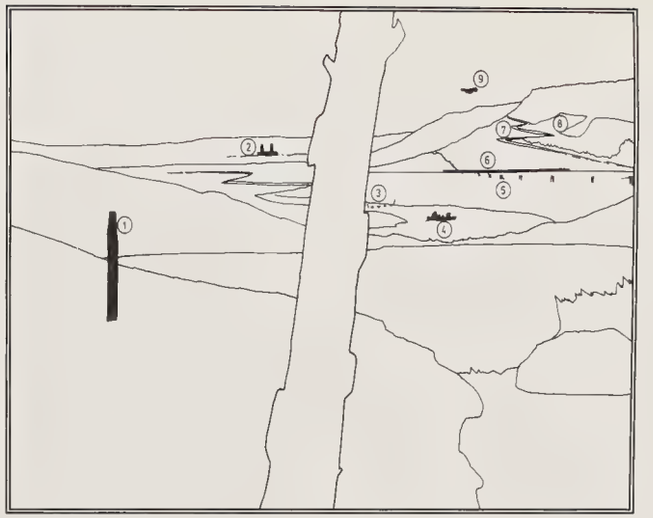
WILDLIFE

Each spring the abundance of water in the Boreal Shield Ecozone attracts hundreds of thousands of ducks, loons, geese and swans. They come either to breed or simply rest and feed before flying on to more northerly nesting grounds. Among the more common waterfowl species that summer here are the Bufflehead, American Black Duck, Wood Duck, Ring-necked Duck and Canada Goose. Also found are the Boreal Owl, Great Horned Owl, Evening Grosbeak and Blue Jay. The songbird perhaps most often associated with this part of the Canadian Shield is the White-throated Sparrow.

Among the characteristic mammals of this ecozone are Woodland Caribou, White-tailed Deer, Moose, Black Bear, Wolf, Lynx, Snowshoe Hare, Fisher, Marten and Striped Skunk. The ecozone's many wetlands, ponds, rivers and lakes provide important habitats for Beaver, Muskrat and Mink.

In the Atlantic marine environment, typical mammals include Grey, Harp and Hooded seals and Sperm, Killer, Atlantic Pilot, Fin and Blue whales. The endangered Northern Right and Bowhead whales and threatened Humpback Whale are also found in this region.

The biologically-rich marine areas off Quebec's north shore as well as the continental shelf of Newfoundland and Labrador are vital to Canada's commercial fisheries. The rocky shores of the Gulf of St. Lawrence and the Newfoundland coast provide exceptional nesting habitat for many seabirds. Lake Trout, Lake Whitefish, Burbot and Northern Pike are among the most common fish species thriving in the ecozone's many freshwater lakes and rivers.



1. *Mining claim post*
2. *Mining smelter*
3. *Fishnet – native domestic fishing*
4. *Canoeists*
5. *Power transmission line*
6. *Train*
7. *Road (logging)*
8. *Clear-cut*
9. *Airplane (outfitters)*

HUMAN ACTIVITIES

Since the days the first humans migrated into the ecozone near the end of the last ice age, the Boreal Shield's sweeping network of rivers and lakes has served as a crucial transportation route, a foundation for rich domestic fisheries, and a natural wellspring of fur-bearing mammals. More recently these waters have come to be known for outdoor recreation and the development of hydro-electric power.

Much of the freshwater resources of the Boreal Shield are relatively untouched by human activity. Others have been widely exploited. Flow alteration and mercury contamination from hydro dams and associated river diversions, acidification from mine tailings and smelter emissions, and sedimentation and stream disruptions from extensive logging activities are the consequences of industrial development.

As for the boreal forest, fire suppression, insect control, clear-cutting and single-species tree farming are widespread. These practices may, over the long term, reduce the diversity of both plant and animal species and increase the forest's vulnerability to disease.

Many Shield lakes and soils are extremely sensitive to changes in pH. Acid rain from local sources and from the long-range transport of airborne pollutants has already taken an ominous toll. It may be weakening the general vigour and growth rate of trees, as well as of aquatic species, in sensitive areas.

Mining, forestry, hydro generation and fisheries are all important contributors to the Canadian economy. With the help of environmentally responsible regulations and policies, they will be able to continue well into the future. Beyond its economic opportunities, the Boreal Shield continues to provide more intangible but priceless gifts – pure air and water, food and habitat for wildlife, and recreational, aesthetic and spiritual benefits.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

9. SHIELD COUNTRY

FURTHER READING

Bastedo. J. 1994. Shield country: life and times of the oldest piece of the planet. Calgary: Arctic Institute of North America. ISBN 0-9190-3479-9.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Johnston, M.E. (ed.). 1994. Geographic perspectives on the provincial norths. Northern and Regional Studies Series No.3. Thunder Bay: Lakehead University, Centre for Northern Studies. ISBN 0-7730-5402-2.

Natural Resources Canada. 1995. The State of Canada's Forests; a balancing act. Fifth report to Parliament. Canadian Forest Service. Hull.

Riewe, R. and Oakes, J. (eds.). 1993. Human Ecology: Issues in the North, Vol. II. Canadian Circumpolar Institute and Faculty of Home Economics, University of Alberta. ISBN 0-9190-5878-7.

Rowe, J.S. 1972. Forest regions of Canada. Publication No. 1300. Ottawa: Environment Canada, Canadian Forestry Service.

Manitoba, Manitoba Environment. 1995. State of the environment report for Manitoba, 1995: focus on agriculture. Winnipeg. ISBN 0-7711-1452-4.

Shugart, H.H., R. Leemans, and G.R. Bonan. 1992. A systems analysis of the global Boreal forest. Cambridge: Cambridge University Press. ISBN 0-5214-0546-7.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19 Environment Canada. Ottawa, Ont. ISBN0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions.

Most of the text was written by Environment Canada staff – Ed Wiken, Harry Hirvonen, V. Neimanis, Annick LeHenaff, Wayne Bond – and many others while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada

KLONDIKE COUNTRY

Boreal Cordillera Ecozone

Consisting of extensive mountains and valleys separated by wide lowlands, this ecozone spans 444 000 square kilometres, occupying the southern Yukon and northern half of British Columbia. It is bordered by the Coast Mountains to the west and extends north from the Montane Cordillera to the Mackenzie and Selwynn Mountains beyond Dawson City and Keno in the Yukon. To the east, it reaches as far as the Peace River country.

The Boreal Cordillera Ecozone contains most of the Yukon's population. Whitehorse is the largest centre with a population of 23 000, while the entire ecozone is home to just 31 000 people (1991). The portion of the ecozone in B.C. is sparsely populated. The relatively small population does not preclude land-use conflicts. Much of the valuable land for residential, agricultural and wildlife habitat is located in confined valleys.

First Nations have a significant voice in managing the environment of the Yukon portion of this ecozone through the Yukon Umbrella Final Agreement signed into law in February 1995. As the individual land claims are settled, the agreements will provide the framework in which future uses of these lands will be adjudicated and reconciled.

1. *Mountain ranges*
2. *Valley glaciation*
3. *Cloud formations*
4. *Flat summit hills*
5. *Mountain river*
6. *Deeply-incised valley*

LANDFORMS AND CLIMATE

The Boreal Cordillera Ecozone encompasses the St. Elias, Skeena, Cassiar, Ominica, and northern Rocky mountains as well as the Stikine, Yukon and Klondike plateaus.

The plateaus generally display the flat to rolling features of mature erosional surfaces and are dissected by streams. Ice age glaciers covered virtually all plateau areas and left widespread deposits of glacial debris. The mountain systems are lower and more subdued than the Coast and southeastern mountains. Deep glacial deposits are widespread in broad valleys, while the mountains – except on the higher ridges and peaks – commonly have a thin cover of colluvial debris.

The climate is an interior subalpine type, and the mean annual temperature is -0.7 to -0.3°C. Average temperatures top 10°C for only one month a year, although up to three months is possible at medium elevations. Mean annual precipitation is 460 to 700 mm with 35 to 60% falling as snow. Winters are long and cold, summers brief and cool. Moist Pacific air frequently causes sudden, often violent storms during summer. A more stable air mass usually prevails in winter, but cold spells can be broken by warm chinook winds.

Above the treeline, at elevations higher than 1 000 to 1 400 metres, alpine weather is the norm. This area is cold, windy and snowy and characterized by low temperatures during the growing season and a short frost-free period. Mean annual temperature ranges from -4 to 0°C. Frost can occur at any time and the average temperature remains below freezing for seven to 11 months each year. Mean annual precipitation is 700 to 3 000 mm, 70 to 80% of which falls as snow. Many high-elevation areas such as the St. Elias Mountains have perpetual ice and snow cover.

1. *White and Black Spruce*
2. *Lodgepole Pine*
3. *Trembling Aspen/Balsam Poplar*
4. *White Birch*
5. *Sedge meadows*
6. *Lichen rock fields*

PLANTS

Lower elevations are generally forested by White Spruce and Subalpine Fir. A pattern apparent in many valleys is intermittent-to-closed forest cover of White Spruce with variable amounts of Pine and Aspen in the valley bottoms and on lower slopes. The best forest growth is associated with White Spruce on fine-textured moist soil near wetlands and water. Subalpine Fir dominates higher up, especially on northern and eastern slopes, where it often forms nearly pure stands. Black Spruce, Lodgepole Pine, and Trembling Aspen are relatively minor species, although locally abundant. Wildfires are not as common as in adjacent ecozones to the east although the occasional stand of Lodgepole Pine, which grows in the aftermath of fires, is not unknown.

Upper elevations near treelines are dominated by deciduous shrubs, mainly scrub birch and willows. Tree species are in stunted or "krummholz" form. The most common krummholz species are Subalpine Fir, Englemann Spruce, White Spruce, Mountain Hemlock, and Whitebark Pine. Groves of stunted aspen and Balsam Fir occur at timberlines, usually on southern slopes. Alpine vegetation consists of shrubs, herbs, moss and lichen, with much of this area totally lacking in vegetation and dominated by rock, ice and snow.

1. *Canada Geese*
2. *Northern Pintail*
3. *Bald Eagle*
4. *Grizzly Bear*
5. *Fox*
6. *Willow Ptarmigan*
7. *Woodland Caribou antler*
8. *Lynx*
9. *Timber Wolf*
10. *Moose antler*

WILDLIFE

The profound effect of the ecozone's climate on wildlife is especially apparent during late summer, when many species migrate south to avoid the abrupt transition to cooler autumn weather and the long cold winters that follow. Moose and Caribou are the most abundant and widespread ungulates. Valley bottoms provide the best winter range for both species, but much of this ecozone is abandoned by mid-winter because of deep snow. Mountain Goats are year-round inhabitants and tend to avoid the deep snow because of the steep terrain they inhabit. Stone Sheep are found on steep south-facing grasslands associated with rugged terrain. Dall Sheep, Grizzly Bear and Black Bear are also present. Other typical forest species are the Spruce Grouse, Common Raven, Gray Jay, Boreal Chickadee, Red-breasted Nuthatch, Three-toed Woodpecker, Ruby-crowned Kinglet, Red Squirrel, Wolverine and Marten. No reptiles are present and the Western Toad, Wood Frog and Spotted frog are the only amphibians.

The many open and shrubby valley bottoms are important as summer range for Moose and Caribou, but are too exposed and snowy to be used as winter range. The Willow Ptarmigan, Arctic Ground Squirrel and Wilson's Warbler are common in these areas.

1. *Tourism and exploration*
2. *Forestry*
3. *Campfire – trapper/hiker*
4. *Canoeing – sports/transportation*

HUMAN ACTIVITIES

Close to half of the ecozone's labour force is engaged in public administration or services, with another 12% in commerce. This reflects, in large part, the nature of Whitehorse, the capital and commercial centre of the Yukon.

Most historic and present-day placer mining is confined to the Klondike plateau in the unglaciated areas of the Klondike, Sixtymile, lower Stewart and Indian River drainages. Of the 21 creeks that produced the most gold between 1978 and 1987, only three were not in these drainages.

Because placer deposits are associated with streambeds, much activity is within the floodplains of streams, which may be dammed, diverted and stripped of vegetation. As a result, impacts on fish habitat and water quality persist long after mining has ceased. Current regulations restrict sediment levels in placer effluent and measures must be taken to restore or compensate for lost habitat.

Important mineral deposits are found within the ecozone. Among these are the Casino deposit (copper-gold-molybdenum), Carmacks deposit (copper-gold) and the Mount Nansen deposit (gold-silver). Major hard rock mining properties in the past have included the lead-zinc mine at Faro, the Keno-Elsa Silver Mine, Ketza River Gold Mine, Mount Nansen Gold Mine and the Brewery Creek Gold Mine. All have been closed in recent years, but Faro reopened recently and a couple of others are planning to resume operations in the near future.

Forestry operations are small and centred around Watson Lake in the Yukon and areas of northeastern British Columbia. The forestry sector is growing and expected to become the major employer and economic contributor for the southeast Yukon.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1.
Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

10. KLONDIKE COUNTRY

FURTHER READING

British Columbia Ministry of Forests. 1995. Forest, Range and Recreation Resource Analysis – 1994. Victoria, B.C. 308 pp. + appendices.

Demarchi, D., R. Marsh, A. Harcombe, and E. Lea. 1989. The Environment: A Regional Ecosystem Outline of British Columbia. The Birds of British Columbia by R. Campbell, N. Dawe, I. McTaggert-Cowan, J. Cooper, G Kaiser, and M. McNall. Royal British Columbia Museum and Canadian Wildlife Service, Victoria, B.C.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Harding, L. and E. McCullum. 1994. Biodiversity of British Columbia; our changing environment. Environment Canada. Canadian Wildlife Service. Vancouver, B.C.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. Ministry of Forests. Victoria, B.C. 330 pp.

Ministry of Environment Lands and Parks and Environment Canada. 1993. State of the Environment Report for British Columbia. Victoria, B.C. 127 pp.

Wiken, E.B. 1986. Terrestrial ecozones of Canada. Ecological Land classification series. No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

Yukon Territorial Government and Environment Canada. 1996. Yukon State of the Environment Report. Whitehorse, Y.T.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by William J. Johnson of Fine Art Studio, London, Ont.

Most of the text was written by Environment Canada staff – Ed Wiken, Harry Hirvonen, John Reid, Ian Marshall and many others. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canada Committee on Ecological Areas (CCEA).

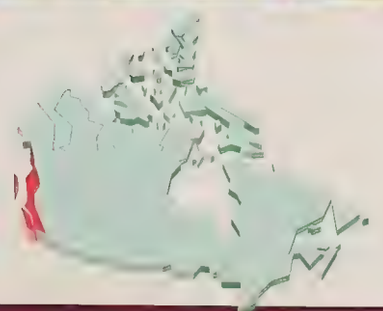
Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



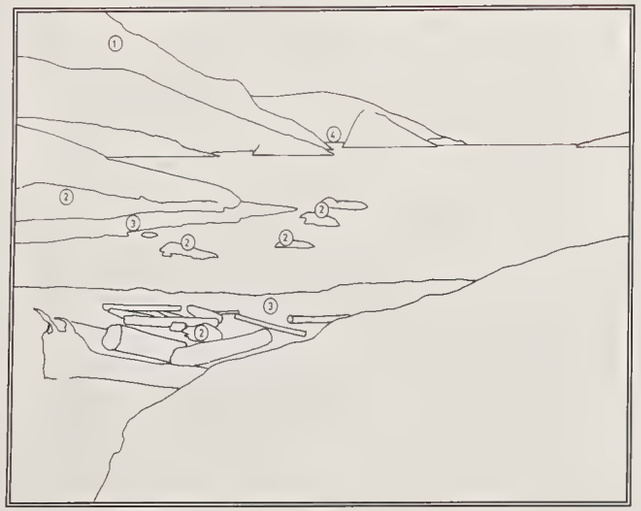
NATURE'S POSTCARD

Pacific Maritime Ecozone

The Pacific Maritime Ecozone is a place of superlatives: Canada's tallest trees, the most rainfall, and the longest and deepest fjords. A unique maritime climate and a striking alliance between lofty mountains and the ever-changing Pacific give this ecozone its distinctive character.

In few other areas on earth can one experience such a variety in so short a distance – from undersea kelp forests to alpine tundra, from the lush, flat plains of the Fraser Delta to the massive glaciers punctuating the northern British Columbia coast.

As the name implies, the ecozone includes the land bordering Canada's Pacific Coast. Covering more than 195 000 square kilometres, it includes the Coast Mountains, B.C.'s marine islands, plus a small corner of southwestern Yukon.



1. *Igneous rocks*
2. *Sedimentary rocks*
3. *Intertidal zone*
4. *Fjord*

LANDFORMS AND CLIMATE

The Coast Mountains dominate most of the ecozone, rising steeply from the fjords and deep channels that line the Pacific coast. Glaciers and snowfields cap the tallest ranges. The ecozone includes Mount Waddington, at 4 000 metres B.C.'s highest mountain. The mountains of Vancouver Island and the Queen Charlotte Islands, although not nearly as high, make up in ruggedness what they lack in elevation. Igneous and sedimentary rocks lie beneath most of the area while fallen rocks and glacial deposits predominate on the surface.

In contrast with the mountains, the Estevan Coastal Plain is a long narrow strip of rocky coastline dotted by the occasional beach. Found only along the west coast of Vancouver Island, this unique landscape is constantly changing as it bears the full brunt of the Pacific's ceaseless waves and scouring winds.

Striking mazes of fjords and channels dissect the coastline from Vancouver to Alaska. These are classic fjords, some of the world's longestand deepest. They slash inland up to 190 kilometres, with sheer sides plunging over 2 000 metres. The deepest ford in the world is Findlayson Channel, with soundings of over 795 metres.

The ecozone lies within the Pacific Ring of Fire, a narrow, semi-circular area known for volcanic eruptions and earthquakes caused by friction between the Earth's crustal plates. Hot springs that beckon back-country adventurers bear testimony to crustal "hot spots" found throughout this area.

This ecozone has some of the warmest and wettest weather in Canada. Its maritime climate receives as little as 600 mm of precipitation per year in the lower Georgia Strait, while the area to the north is typically much wetter, receiving up to 3 000 mm. Compared to the rest of Canada, there is little variation in monthly temperatures. Averages in July range between 12 and 18°C and, in January, between 4 and 6°C. The frost-free period is up to 220 days long in the moist southerly valleys, decreasing to about 100 days in the mountains.

1. *Western hemlock*
2. *Red alder*
3. *Yellow cedar (cypress)*
4. *Sitka spruce*
5. *Sword fen*
6. *Skunk cabbage*
7. *Salmonberry*
8. *Devil's club*
9. *Pacific dogwood*
10. *Western bleeding heart*
11. *Salal*
12. *Kelp bed*
13. *Douglas fir*
14. *Red huckleberry*
15. *Bracket fungus*
16. *Red cedar*
17. *Old man's beard*
18. *Red elderberry*
19. *Moss*
20. *Calypso orchid*
21. *Viola langsdorfii*

PLANTS

The combination of heavy rainfall and year-round mild temperatures support some of the most spectacular temperate rain forests in the world. Here are Canada's most productive forests and its biggest and oldest trees. A record-breaking Douglas Fir near Red Creek measures over 14 metres around and 80 metres high; a western Red Cedar on Meares Island is 20 metres around; Carmanah Creek is home to the world's tallest Sitka Spruce at 95 metres; Cathedral Grove is dominated by Douglas Fir as tall in feet as they are old in years – up to 250 feet (85 metres). Yet these trees are still young compared to other western Red Cedars, which reach over 2 000 years of age.

The forest ecosystems found here vary with elevation and precipitation. In low-lying coastal areas, Western Hemlock forests dominate; in higher elevations subalpine Mountain Hemlock forests are more common; and small areas of dry Douglas Fir forests are found on the leeward side of the mountains. It is the coastal Western Hemlock forests that make up the famous rainforests of this ecozone.

Coastal temperate rainforests are globally scarce, originally covering barely 0.2% of the earth's land area. Today, the largest undeveloped tracts of these forests are found in South America and North America, much of which – approximately 106 000 square kilometres – is in the Pacific Maritime Ecozone. These forests contain ecosystems with the highest biomass per hectare on Earth. The western coastal forest is composed mostly of Western Red Cedar, Western Hemlock, Douglas Fir, Mountain Hemlock, Amabilis Fir, Sitka Spruce, Yellow Cedar and Alder. Douglas Fir is confined largely to southern regions while, in the north, Amabilis Fir is more common. As the elevation increases, the Mountain Hemlock and Yellow Cedars give way to stunted clumps of trees known as "krummholz." Above 900 metres, treeless alpine tundra takes over.

A unique forest ecosystem in the dry rainshadow climate of the Gulf Islands and Saanich Peninsula is the Arbutus and Garry Oak woodland. Among B.C.'s rarest forests, it is considered one of the most endangered ecosystems in North America. Urbanization, wildfire suppression and the introduction of exotic species such as Scotch Broom have destroyed about 95% of its original range.

1. *Bald eagles*
2. *Glaucous-winged gull*
3. *Black bear*
4. *Tree snail*
5. *Black-tailed deer*
6. *Winter wren*
7. *American black oystercatcher*
8. *Harlequin ducks*
9. *Sea stars*
10. *Northern saw-whet owl*
11. *Gulls in large group, indicative of salmon attacking "ball-up" of herring*
12. *Steller's jay*
13. *Pelagic cormorant*
14. *Northern sea lion*
15. *Harbour seal*
16. *Tufted puffin*
17. *Mountain lion*
18. *Sea urchin shell, carried up from shore by predator*
19. *Chestnut-backed chickadee*
20. *Killer whales*
21. *Sooty blue grouse*

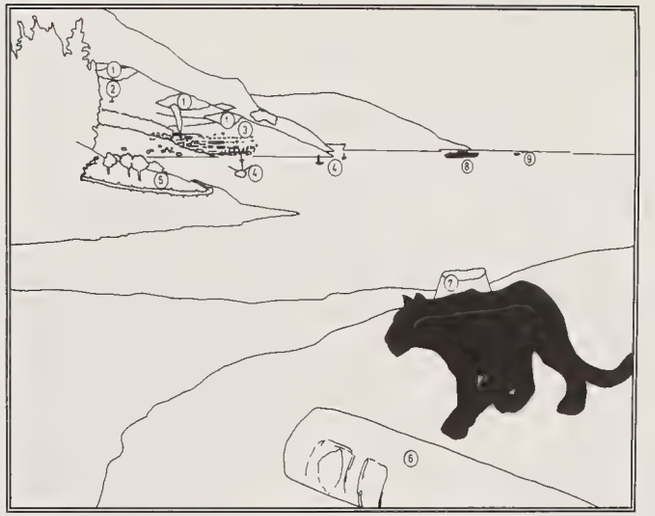
WILDLIFE

Characteristic land mammals of this area include the Black-tailed Deer, Black and Grizzly bears, Mountain Lion (or Cougar), Fisher, and American Pika. Bird species unique to this area include the American Black Oyster Catcher, Tufted Puffin, Chestnut-backed Chickadee and, in southern regions only, the California and Mountain Quail. Other representative birds are the Northern Saw-whet Owl, Northern Pygmy Owl, Steller's Jay, Bald Eagle and Blue Grouse.

Several species and subspecies of wildlife evolved on the islands of the region: the Vancouver Island Marmot, found only in alpine meadows on Vancouver Island; the "Blond" or "Kermodei" bear, a subspecies of Black Bear found on a few north coastal islands; and the Roosevelt Elk, among others. Some are rare or endangered; others, such as the Dawson Caribou, once confined to Graham Island, are extinct.

The marine ecosystems of the ecozone support a tremendous abundance and diversity of organisms. Many seabirds, including the little-known Marbled Murrelet, nest along the coast. The area's many islands, estuaries and fjords provide critical habitat for countless migrating shorebirds and waterfowl, including the Trumpeter Swan and Sandhill Crane. Contributing to the richness of the ecosystem are a shallow continental shelf, ice-free coastal waters, deep-water upwellings of nutrients, and numerous freshwater discharges from coastal rivers.

Typical marine mammals include the Northern Sea Lion, Northern Fur Seal, Harbour Seal, and a host of whales: the giant Beaked Whale, Sperm Whale, Grey Whale, Killer Whale, Pacific Pilot Whale and Blue Whale. The endangered Sea Otter has been reintroduced to the northwest coast of Vancouver Island. Several species of salmon and their spawning streams are located throughout the ecozone. Pacific Herring and Pacific Halibut are also found here. Common freshwater species include the Cutthroat Trout, Dolly Varden, and Steelhead.



1. *Clear-cut logging and logging roads*
2. *Helicopter*
3. *Urban development, sawmill, harbour*
4. *Fishing boats*
5. *Farmstead with fruit trees0*
6. *Totem pole*
7. *Logged stump*
8. *Cruise ship*
9. *Barges*

HUMAN ACTIVITIES

Although the Pacific Maritime Ecozone is rich in wild fauna, flora, and ecosystems, much of the south is heavily stressed by population growth, urban development, and the forestry and pulp and paper industries.

Three-quarters of British Columbians, or about 2.5 million people, live here. Most are concentrated in the Georgia Basin, the area embracing the large urban centres of the Lower Mainland and Victoria. The population has grown by leaps and bounds over the past few decades, largely as a result of immigration. For instance, the population of the Gulf Islands rose by an astonishing 58% between 1971 and 1985. Rapid urbanization makes protecting wildlife habitats and prime agricultural land particularly challenging.

For well over a century, logging and related forest industries have been the economic mainstay of many communities in this ecozone. They have also changed the landscape dramatically. In the past 120 years, over 2 million hectares of the temperate coastal rainforest were clear-cut. Between 1920 and 1992, while the area logged each year doubled in the rest of Canada, it tripled in the Pacific Maritime.

The commercial fishing industry is another major player in the ecozone.Both native and aquaculture stocks of salmon are especially prized. Most Sockeye, Pink, and Chum Salmon stocks have increased since the 1960s. However, Chinook and Coho Salmon stocks are low due to overfishing, habitat damage, and natural factors. Contamination by organochlorine compounds released from pulp mills sometimes interferes with the harvesting of shellfish, as the toxins tend to accumulate in their tissues.

Since the days when the native Haida people routinely plied their dugout canoes along the west coast, the area has been an important marine transportation route. Boat traffic now includes huge cargo ships, fishing vessels, ferries, and all kinds of recreational craft. A fast-growing industry here is water-based tourism, offering everything from sea kayaks to multi-level tour boats for visitors eager to whale-watch or drink in the wondrous landscape.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

11. NATURE'S POSTCARD

FURTHER READING

British Columbia Ministry of Environment, Lands and Parks and Environment Canada. 1993. State of the Environment Report for British Columbia. Victoria, B.C. ISBN 0-7726-1773-2.

British Columbia Round Table on the Environment and the Economy. 1994. State of Sustainability: Urban Sustainability and Containment. British Columbia Round Table on the Environment and the Economy. Victoria, B.C. ISBN 0-7726-2188-8.

Demarchi, D., R. Marsh, A. Harcombe, and E. Lea. 1989. The Environment: A Regional Ecosystem Outline of British Columbia. The Birds of British Columbia by R. Campbell, N. Dawe, I. McTaggert-Cowan, J. Cooper, G Kaiser, and M. McNall. Royal British Columbia Museum and Canadian Wildlife Service, Victoria, B.C.

Fraser Basin Management Board. 1995. State of the Fraser Basin. Fraser Basin Management Board (Canada). Vancouver, B.C. ISBN 0-6622-3429-4.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Harding, L.E. and E. McCullum. 1994. Biodiversity in British Columbia: Our Changing Environment. Environment Canada. Canadian Wildlife Service. Vancouver, B.C. ISBN 0-6622-0671-1.

Lewis, K.T. and A. MacKinnon. 1992. Gap Analysis of B.C.'s Protected Areas by Biogeoclimatic and Ecoregion Units: Draft. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests. Victoria, B.C.

Wiken, E.B. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series. No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions

Most of the text was written by Environment Canada staff – Ed Wiken, Harry Hirvonen, Wayne Bond and Ian Marshall – while some was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA)

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada

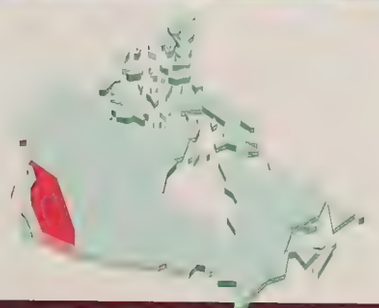
Montane Cordillera Ecozone

The Montane Cordillera Ecozone is the most diverse of Canada's 15 terrestrial ecozones, exhibiting some of the driest, wettest, coldest, and hottest conditions anywhere in the country. The ecosystems are variable, ranging from alpine tundra and dense conifer forests to dry sagebrush and grasslands. Much of the region is rugged and mountainous.

The ecozone covers 473 000 square kilometres of Canada, stretching from north-central British Columbia south to the United States border. It encompasses the Alberta Foothills as well as the interior mountain ranges and valleys of B.C., including the Okanagan and the East Kootenay valleys.

The Montane Cordillera encompasses two of the four significant agricultural areas of the province; the Creston Valley and the Okanagan Valley. In the latter, orchards, vineyards and cash crops take advantage of favourable soil conditions. Cattle ranching is dominant throughout much of the other interior plateau and valley lands.

Forestry is the major industry of the lower and middle slopes, while the interior wet belt is the most productive fibre production area in the inland of B.C. Mining is an important activity within the ecozone – five of B.C's eight coal mines and three of Alberta's 11 are located within its boundaries.



SOUTHERN ROCKIES

1. *Mountain ranges*
2. *Valley*
3. *Rivers*
4. *Beach*
5. *Wetland*
6. *Rock outcropping*

LANDFORMS AND CLIMATE

The 473 000 square kilometres of the Montane Cordillera Ecozone stretch from north-central British Columbia southeast to the southwestern corner of Alberta. Wetlands and small lakes dot the landscape, but there are also large, deep lakes and major river systems, including the Fraser and the Columbia River headwaters.

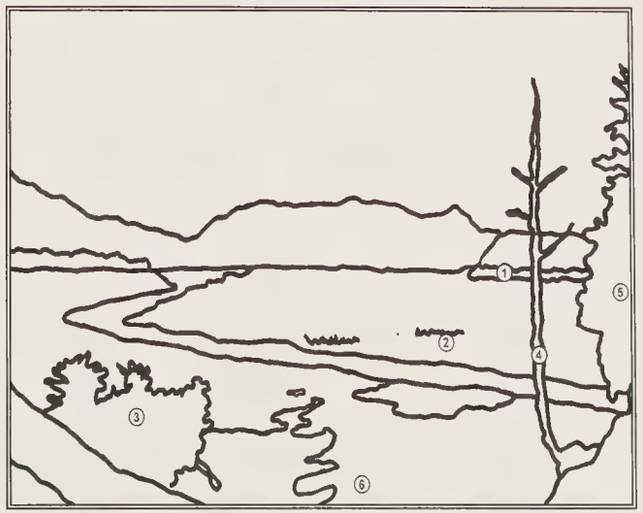
Mountains prevail in this area. The major plains are more extensive in the north and extend out as intermontane valleys towards the southern half of the ecozone. Most of these plains and valleys are covered by glacial moraine and to some degree ancient riverbed and lakebed deposits, whereas the mountains consist largely of fallen rock debris and rocky outcrops.

The Columbia and Rocky mountains within this ecozone have a complex geology consisting largely of folded and faulted sedimentary bedrock. The mountain cliff faces disintegrate rapidly to form course, rocky slopes, fans and aprons.

Moist Pacific air carried by westerly winds drops large amounts of rain and snow as it ascends the windward side of the Coast Mountains. The air drops over the eastern slopes into the Montane Cordillera, where it compresses and warms, causing clouds to thin out. The pronounced rainshadow cast by the massive Coast Mountains makes the valley bottoms of the south-central interior the driest climates of B.C. The air releases moisture again, creating an interior rain belt as it ascends the Columbia, Skeena, Omineca, Cassiar, and finally the Rocky mountains, which define the eastern extent of this ecozone.

Annual precipitation in the higher elevations ranges between 1 200 and 2 200 mm. The northern and interior portions of the ecozone receive between 500 and 800 mm annually. The driest rainshadow areas around Merritt and Cache Creek and the southern Okanagan receive well below 500 mm of precipitation.

Much of the ecozone has an interior continental climate dominated by easterly moving air masses that produce cool wet winters and warm dry summers. Periodic inundation by dry, high-pressure, continental air masses results in a few cold winter days and a few hot summer days. Temperatures vary with altitude. In the alpine, no month has an average daily temperature above 10°C. The upper forested slopes have seven to nine months per year of monthly mean temperatures of no more than 0°C. The Ponderosa Pine forests are the driest and, in summer, the warmest forests in B.C., with mean July temperatures averaging 17°C to 22°C. The hot, dry summers result in large moisture deficits during the growing season. The rainshadow grasslands and valley bottoms are characterized by hot, dry summers and moderately cold winters with little snowfall. It is not unusual to have daily high summer temperatures topping 30°C.



1. *Douglas Fir*
2. *Forage Grass*
3. *White Spruce*
4. *Lodgepole Pine*
5. *Ponderosa Pine*
6. *Bunchgrass/sedges*

PLANTS

Vegetative cover varies widely; alpine environments contain various herbs, lichen and shrubs, whereas the subalpine regions are dominated by tree species such as Alpine Fir and Engelmann Spruce With decreasing elevation, the mountainous slopes and rolling plains split into three forest groups: a marginal band at upper elevations characterized by Engelmann Spruce, Alpine Fir and Lodgepole Pine; a second zone characterized by Ponderosa Pine, interior Douglas Fir, Lodgepole Pine and Trembling Aspen in much of the southwest and central portions; and another featuring western Hemlock, western Red Cedar, interior Douglas-fir, and western White Pine in the southeast.

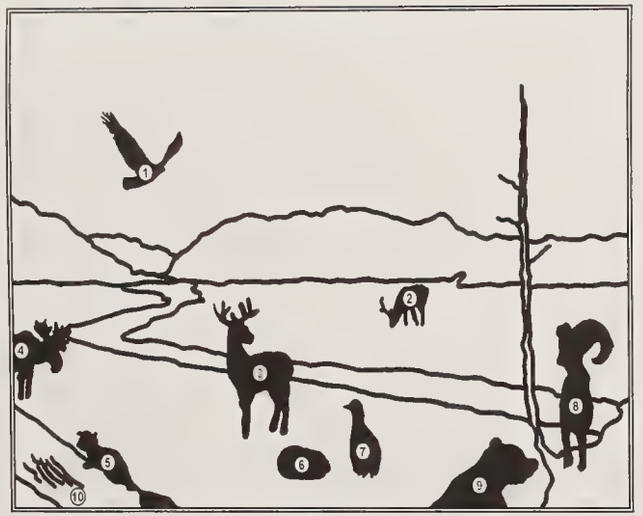
The Englemann Spruce-Subalpine Fir belt occurs at elevations of between 1 200 and 2 300 metres. It forms a continuous cover at its lower and mid elevations and becomes subalpine parkland at its upper limits. Lodgepole Pine is widespread after fire and is predominant in the drier regions. Other common species include Whitebark Pine and Alpine Larch. Subalpine heather and grassy meadows are also common. Snow avalanche tracks are evident throughout much of the high-snowfall areas.

High-elevation forest gives way to one dominated by White Spruce, interior Douglas Fir and Lodgepole Pine at mid elevations of 400 to 1 500 metres. Where the precipitation is relatively high (up to 1 500 mm annually) an interior wet belt forms, dominated by tree cover of western Red Cedar and western Hemlock. This area is concentrated on the lower slopes of the Columbia Mountains and the windward side of the Rockies and much of the Shuswap and Quesnel highlands.

At lower elevations, particularly along dry valleys, Ponderosa Pine is dominant. Wildfires play an important role maintaining these forests. Stands are often open and park-like with an understorey of bluebunch wheatgrass. More moist sites are characterized by Douglas Fir, and water and paper birches, while the dry southern interior is devoid of trees and dominated instead by big sagebrush, rabbit-brush and antelope-brush. Grasslands featuring bunchgrasses and other grasses and shrubs appear in the valley bottoms and on plateaus in south-central B.C. from Riske Creek in the north to the Canada-U.S. border. Similar grasslands occupy smaller areas in the Kootenays of southeastern B.C.

The natural grasslands in this ecozone have not fared well. Most existing prior to European settlement have vanished, thanks to fire suppression, introduced species, and cattle grazing. Much of the grassland in the Okanagan Valley, for example, has been completely replaced by settlements, orchards, and crops. Today, introduced species have colonized many grasslands and the pockets of natural dry grasslands that survive are unique to Canada, dominated by species such as Bluebunch Wheatgrass that rarely occur east of the Rocky Mountains.

Extensive wetlands are infrequent in the mountainous portions of this ecozone. On slopes, wetlands are generally restricted to small transitional and non-forested bogs, marshes and skunk cabbage swamps. Much of the valley wetlands have been destroyed by urbanization and agriculture. Less than 15% of the original wetlands of the Okanagan Valley remains and is under constant threat from development.



1. *Gyrfalcon*
2. *Woodland Caribou*
3. *Whitetail Deer*
4. *Moose*
5. *Red Squirrel*
6. *Wolverine*
7. *Willow Ptarmigan*
8. *Bighorn Sheep*
9. *Grizzly Bear*
10. *Black Bear marks*

WILDLIFE

Wildlife is as diverse as the vegetative cover. In the alpine tundra, the snowpack does not melt until well into summer and plant life is sparse. Several species have adapted to the harsh climate, including Mountain Goat, Gyrfalcon, White-tailed and Willow Ptarmigan, Water Pipit and Rosy Finch. Mule Deer, Rocky Mountain Elk, Stone Sheep, Grizzly Bear and Black Bear are common in lush meadow habitats and the stunted spruce groves known as krummholz.

Throughout the middle and upper elevations ungulates such as Mountain Goat, Moose, Caribou and Mule Deer are common. Rocky Mountain Elk, Bighorn Sheep, White-tailed Deer and Stone Sheep are found less frequently. Grizzly Bear and Black Bear are the most common large mammals. The conifer forests are also important habitat for fur-bearers such as Marten, Fisher, Red Squirrel and Wolverine and a diverse collection of birds that feed on conifer seeds, bark insects and small mammals. Common birds include Pileated Woodpecker, Northern Flicker, Clark's Nutcracker and Red Cross-bill.

Ponderosa Pine parklands provide habitat for species that forage on large conifer seeds (Clark's Nutcracker, Pygmy Nuthatch and Yellow-pine Chipmunk), bark insects (Northern Flicker and White-headed Woodpecker) or flying insects (Common Poorwill). The open forest canopy passes sufficient light for the production of shrubs palatable to wintering ungulates (Mule Deer and White-tailed Deer). Dense stands of Douglas Fir and Ponderosa Pine, meanwhile, provide a warm cover for wintering ungulates and an abundant seed and insect source for a variety of birds, small mammals, and coyotes.

The treeless bunchgrass areas are small relative to the adjacent forests, but they have an abundance and diversity of wildlife. This is partly due to the wide range of habitats created by the juxtaposition of grasslands, shrublands, wetlands and forest. The grasslands also represent a northern extension of the intermontane steppe of the western Great Basin in the south. Southern species such as Pallid Bat, Burrowing Owl and Short-horned Lizard reach their northern breeding limit here. On the other hand, northern species that rarely move further south, such as Snowy Owl and Gyrfalcon, can be found on open rangelands in winter.

Encroachment and pressures of development on the grasslands and lower slopes of many of the valleys within this ecozone have led to the destruction of habitat for many indigenous species. In 1995, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed seven mammals that inhabit this ecozone as vulnerable. COSEWIC also lists 10 bird species as either vulnerable or threatened and four – Mountain Plover, Sage Thrasher, Burrowing Owl and Peregrine Falcon (anatum) – as endangered. Four fish species and seven plants are also listed by COSEWIC.

1. *Industry*
2. *Mining exploration*
3. *Recreation*
4. *Orchards*
5. *Transportation*
6. *Ranching*

HUMAN ACTIVITIES

As the dry Ponderosa Pine is of limited commercial value for forestry, the dominant land use is cattle grazing. Grasslands, although chronically overgrazed in the past, are now better managed. Flat areas, especially on ancient riverbeds and lakebeds, are irrigated for hay production. Overall, the arable land in B.C. accounts for less than 5% ofits total land base. The Montane Cordillera encompasses two of the few significant agricultural areas of the province: the Creston Valley and the Okanagan Valley. In the latter, favourable soils, when irrigated, are used for orchards and vineyards as well as cash crops.

The forested lower slopes often provide summer range for cattle Forestry is the main industry of the lower and middle slopes with the interior wet belt being the most productive area for fibre production of all of the inland areas of B.C. Nine pulp and paper mills are located throughout the ecozone. The Fraser-Thompson River systems have seven such operations: three near Prince George, two at Quesnel, one at Williams Lake and one at Kamloops. The others are at Castlegar and Skookumchuk on the Columbia River. In addition, many small and large sawmills are found throughout the ecozone. Canada is the largest exporter of forest products in the world and B.C. produces 45% of the Canadian total. Although no specific figures are available by ecozone, the Montane Cordillera is a substantial contributor to the B.C. forest sector.

Mining is another important activity within the ecozone. Five of B.C's eight coal mines and three of Alberta's 11 occur within its boundaries. A major lead-zinc refinery is located at Trail. Copper, gold, silver, molybdenum and other precious metals are also mined within the ecozone and two areas are seeing active diamond exploration.

This ecozone contains six national parks, including the oldest in Canada, Banff National Park. As well, there is an extensive network of provincial parks. The largest provincially protected area is Ts'yl-os, a 2 332-square-kilometre park that is home to California Bighorn Sheep and B.C.'s third largest salmon run. A major concern is that many parks, most notably those of the Rocky Mountains, are becoming islands in a sea of development, their ecological integrity threatened by habitat destruction and fragmentation.

Within these parks, roads and railways remove habitat, form barriers to the movement of wildlife, and are a direct cause of wildlife mortality. Townsites and other developments further fragment the landscape. Outside the parks, adjacent lands that once formed extended blocks of wilderness are now subject to a variety of pressures, including new roads and industrial activities.

The dry valleys and lower slopes have intense recreational use, including hiking, cycling, horseback riding and some hunting and fishing. Most of the major lakes are lucrative tourist attractions, thanks to the many beaches and hot summers of this ecozone. Land-use conflicts are common in the valleys as a result of the pressure from the agricultural, recreational, transportation and industrial sectors, as well as urban development and the needs of wildlife.

Many of the interior cities have grown substantially over the past 20 years. For example, from 1971 to 1991 Kamloops grew 55% to 68 000 and Prince George by 42% to 70 000. With urbanization has come extensive transportation and communication networks, and major population centres in Alberta and the Lower Mainland of British Columbia have increased recreational pressure on the ecozone. With a growing population base of over four million to draw from, these pressures are not insignificant.

The labour force within the ecozone is becoming increasingly service-oriented. Of the total labour force, 32% are employed in the service sector, 15% in commerce, 11% in forestry, 7% in construction, 5% in agriculture, 5% in transportation, and 4% in mining.

Urbanization and industrialization have placed increased pressures on both the quantity and quality of water supplies. Shortages are now common in parts of the Okanagan and Thompson basins, particularly in summer when demand is high but runoff low. The impact of pulp mill effluent on the Fraser and Thompson rivers is also cause for concern. However, great strides have been made recently toward the elimination of organochlorine compounds and suspended solids as companies work to meet regulations that require reductions of dioxins and furans to below detectable levels.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1.
Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

12. SOUTHERN ROCKIES

FURTHER READING

British Columbia Ministry of Forests. 1995. Forest, Range and Recreation Resource Analysis – 1994. Victoria, B.C. 308 pp. + appendices.

Demarchi, D., R. Marsh, A. Harcombe, and E. Lea. 1989. The Environment: A Regional Ecosystem Outline of British Columbia. The Birds of British Columbia by R. Campbell, N. Dawe, I. McTaggert-Cowan, J. Cooper, G. Kaiser, and M. McNall. Royal British Columbia Museum and Canadian Wildlife Service, Victoria, B.C.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Harding, L. and E. McCullum. 1994. Biodiversity of British Columbia: our changing environment. Environment Canada. Canadian Wildlife Service. Vancouver, B.C.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. Ministry of Forests. Victoria, B.C. 330 pp.

Ministry of Environment Lands, and Parks and Environment Canada. 1993. State of the Environment Report for British Columbia. Victoria, B.C. 127 pp

Wiken, E.B. 1986. Terrestrial ecozones of Canada. Ecological Land Classification Series. No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by William J. Johnson of Fine ArtStudio, London, Ont.

Most of the text was written by Environment Canada staff – Harry Hirvonen, Ed Wiken, Ian Marshall, Wayne Bond and many others. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

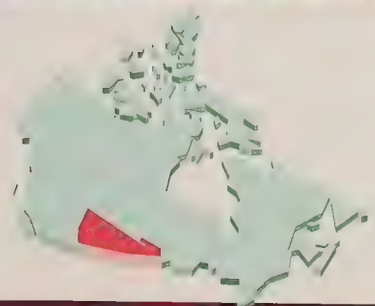
Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



GREAT PLAINS

Prairie Ecozone

The Prairie Ecozone is often characterized as flat, rural, wheat- and oil-producing, or cold. The terms describe significant aspects of the environment and the economy but understate its diversity and recent evolution.

This ecozone is part of the Interior Plains of Canada, which are a northern extension of the Great Plains of North America. The relief is typically subdued, consisting of low-lying valleys and plains sloping eastward. With its base along the Canada-United States border, the ecozone stretches from the Rocky Mountains in Alberta to the Red River valley in Manitoba, reaching across the southern third of the Prairie provinces.

The Prairie Ecozone, spanning an area of 520 000 square kilometres, is larger than the Yukon Territory and is one of the Canadian regions most altered by human activity. Farmland dominates the ecozone, covering nearly 94% of the land base.

Termed the Breadbasket of Canada, the Prairie Ecozone contains the majority of the country's productive agricultural cropland, rangeland, and pasture. The area is the source of much of our food and, as a result of the export of grains, oilseeds, and animal products, is an important source of foreign exchange.

Agriculture is the major agent of change in this ecozone, influencing most native communities of plants and animals. Loss of habitat is the most critical threat to the flora and fauna. Little of the natural vegetation is left, a situation that made life difficult for some animals unique to the grasslands. Wetlands, which provide critical habitat for 50% of North America's waterfowl, have been altered by agricultural practices and only half the presettlement wetland area remains. Today, the Prairie Ecozone is home to high numbers of threatened and endangered wildlife species and its native ecosystems are among the most endangered natural habitats in Canada.

1. *Hummocky moraine*
2. *Prairie potholes (kettle ponds)*
3. *Coulees*
4. *Boulder*
5. *Salinified pond*
6. *Shale outcropping*
7. *Lacustrine plain*

1. *Wheat Grass*
2. *Smooth Aster*
3. *Canada Goldenrod*
4. *Prickly Pear Cactus*
5. *Prairie Sage*
6. *Sedges*
7. *Cattails*
8. *Willows*
9. *Western Snowberry*
10. *Blue Grama Grass*
11. *Prairie Rose*
12. *Spear Grass*
13. *Silverberry*
14. *Chokecherry*
15. *Saskatoon*
16. *Manitoba Maple*
17. *Aspen*

LANDFORMS AND CLIMATE

Multiple glaciations have shaped the Prairie Ecozone. Continental glaciation flattened the landscape and left behind a variety of glacial deposits. For example, the flat fertile plain that dominates southern Manitoba resulted from the heavy clay soils that lay beneath the former glacial Lake Agassiz. Cedar Lake and lakes Manitoba, Winnipeg, and Winnipegosis are remnants of this bygone inland sea. Ponds and small lakes occupy many of the depressions in moraines. Following the glacial retreat 8 000 to 11 000 years ago, the ecozone evolved into treeless grasslands covering the southern third of what is now Alberta, Saskatchewan, and Manitoba.

Underlying these surface landforms are horizontal layers of sedimentary bedrock consisting of various Cretaceous and Tertiary sediments. Trapped in isolated pockets and cracks are rich reservoirs of oil and gas.

The Prairie Ecozone is now typified by large tracts of flat to rolling plains. A great variety of surface landforms, from hummocky lands to deeply entrenched river valleys, also exist.

Most of the major rivers have their origin in the Rockies. These rivers flow east across the ecozone and are fed by rainfall, snowmelt, and glacial runoff at their headwaters. Many smaller rivers and streams of the Prairie Ecozone have highly variable flows and are often dry for long periods.

The ecozone's climate is determined by its location in the heart of North America and by the neighbouring Rocky Mountains, which block moisture-bearing winds from the Pacific. The result is a pronounced, subhumid to semi-arid climate. Winters are very cold. The mean temperature in the coldest month is -9.4°C at Lethbridge and -18.3°C at Winnipeg. Summers are short and warm. Mean temperatures for the warmest month are 16.1°C at Edmonton and 19.7°C at Winnipeg. Although dry, arctic air predominates in winter, periodic chinooks (strong, warm and dry westerlies that blow in from the Rockies) bring spring-like conditions to southern Alberta and, to a lesser extent, southern Saskatchewan, reducing snow cover and removing moisture from an already dry region.

A water deficit is typical as the ecozone receives considerably less precipitation than other parts of Canada and the world. Annual precipitation is extremely variable, ranging from 250 mm in the arid grassland regions of southwest Saskatchewan and southeast Alberta to slightly less than 700 mm in the Lake Manitoba plain, the warmest and most humid region in the Prairie Ecozone. About a quarter of the precipitation falls as snow. Summer thunderstorms are often severe, and south-central Alberta is reputed to be one of the worst hailstorm belts in North America. In summer, warm, moist air masses from the southern United States invade southern Manitoba, causing numerous thunderstorms and occasional tornadoes.

High winds predominate in the ecozone. Mean annual wind speed in many places is 18 to 21 km/h. In contrast, Vancouver's mean annual wind speed is 12 km/h while Toronto's is about 16 km/h. Wind accelerates evaporation, causing much of the dryness. In combination with precipitation and evaporation patterns, wind determines the amount of soil erosion and the resulting land degradation.

PLANTS

The shift from grassland to cropland in the Prairies has increased losses of organic matter and plant nutrients from the soil. It is estimated that the original organic matter levels have fallen by 40 to 50%. Over the past century the ecozone has been radically transformed and only a small fraction remains in its native state. Perhaps less than 1% of the Tall-grass Prairie, 18% of the Short-grass Prairie, and 24% of the Mixed-grass Prairie remain.

Today, the Tall-grass Prairie region of Manitoba is almost completely cultivated. Over 90% has been converted to crops or drastically changed by grazing and haying. And 75% of the Mixed-grass Prairie and Aspen Parkland has been converted to cropland or seeded to non-native forage species. The Aspen Parkland, the northern transition zone to the Boreal Forest, has expanded south into former grasslands since settlement put an end to prairie fires. The natural vegetation is generally dominated by Spear Grass, Wheat Grass, and Blue Grama Grass. Sagebrush is abundant. Local saline areas feature Alkali Grass, Wild Barley, Greasewood, Red Sampire, and Sea Blite. Drier sites in the southwest are home to yellow Prickly Pear Cactus.

The Short-grass Prairie occupies the driest southerly arc of the region, where brown and dark brown soils are dominant. The northern edge of the ecozone is dotted with groves of Trembling Aspen and Balsam Poplar and characterized by black Chernozemic soils. The most productive soils in the region are the black, dark grey, and dark brown soils of the Aspen Parkland and the Tall-grass and Mixed-grass Prairie.

Lakes and wetland areas are rich in vegetation. Depending upon rainfall, there are between 1.6 and 7.1 million wetlands in this ecozone, and lakes cover 7 800 square kilometres. The greatest number of wetlands occur along the subhumid Northern Grasslands and adjacent Aspen Parkland, where they make up half the land area. However, lake and wetland areas are under threat. Virtually every major natural water system has been extensively modified and developed for hydro and thermal power generation, irrigation, flood protection, and water management. Agriculture and urbanization have cut the number of wetlands in half.

Few deciduous trees and shrubs grow in the ecozone except in the eastern regions, sheltered locations along waterways or at upper elevations. The east is characterized by Trembling Aspen and shrubs, whereas the southwest displays a mixed montane-type open forest of Lodgepole Pine. Southwest Manitoba contains a forest reserve that occupies most of the higher elevations of Turtle Mountain.

1. *Thirteen-lined Ground Squirrel*
2. *Richardson Ground Squirrel*
3. *Grasshopper Sparrow*
4. *Western Meadowlark*
5. *Pronghorn Antelope*
6. *Snow Goose*
7. *Ferruginous Hawk*
8. *American Avocet*
9. *Northern Harrier*
10. *Black-billed Magpie*
11. *Coyote*
12. *Sharp-tailed Grouse*
13. *Burrowing Owl*
14. *Badger*
15. *Whitetail Jackrabbit*
16. *Northern Pintail*
17. *Waterfowl (fall plumage)*
18. *Lesser Scaup*
19. *Canada Goose*
20. *Whitetail Deer*
21. *Pallid-winged Grasshopper*

WILDLIFE

The Prairie Ecozone provides habitat for many animal species. Intermittent sloughs and ponds on the plains offer major breeding, staging, and nesting grounds for migratory waterfowl using the Central North American flyway. More than half of all North American ducks are born in Prairie Ecozone wetlands. River valleys also offer sheltered habitats important to wildlife, especially during the harsh winters. The Prairies offer unique habitat for the Black-tailed Prairie Dog, while its southern region is home to the Short-horned Lizard and Western Rattlesnake. Manitoba provides habitat for Black Bear, Moose, Sharp-tailed Grouse, Beaver, and Red Fox. Also present are various species of frog and toad. Local fish include Walleye, Lake Whitefish, and Northern Pike.

Considering its area and population, the Prairie Ecozone has a disproportionate number of threatened and endangered wildlife species. At least four vertebrate species – the Plains Grizzly, Swift Fox, Black-footed Ferret, and Greater Prairie Chicken – have disappeared from the area. The Peregrine Falcon, Mountain Plover, Eskimo Curlew, Piping Plover, Burrowing Owl, and Whooping Crane are all endangered.

Agriculture has probably had the greatest impact on the ecozone. By replacing natural grasslands with crops, draining wetlands, and destabilizing natural chemical balances in the soil with pesticides, the number and range of wildlife species has changed dramatically. As well, competing, non-native species have been introduced.

Within aquatic ecosystems, high-value fish stocks are under pressure, particularly Walleye and Sauger, which are prized by commercial and recreational fishers. Stocks have been reduced through overfishing and are sensitive to water quality in the controlled-drainage systems as well as to natural fluctuations. For example, contaminants from the widespread use of pesticides have damaged fish habitat.

1. *Cities/Towns*
2. *Oil Pump-Jack*
3. *Cropped fields*
4. *Farm buildings*
5. *Grazing lands*
6. *Farm machinery*
7. *Road infrastructure*
8. *Plains Indian tent ring*

HUMAN ACTIVITIES

Between 1670 and 1870, the Hudson's Bay Company was granted exclusive fur trading rights to the area drained by the rivers flowing into Hudson Bay, then called Rupert's Land.

The earliest significant human modification of the native prairie ecosystems was spurred by European demand for products of the fur trade, particularly those from bison. The killing of thousands of bison each year by European settlers led to the virtual elimination of free-roaming bison by the 1880s.

Settlement and landscape modification greatly increased after 1870, when the Hudson's Bay Company surrendered its charter and sold Rupert's Land to Canada. To secure the area against potential encroachment by the United States, Canada encouraged land development. In the early part of this century, following the completion of the transcontinental railway in 1885, a massive migration saw more than 200 000 homesteaders stake their claims.

Railways played a leading role in defining the pattern of development. Towns emerged along the rail line as collection points for grain and livestock exports and as distribution points for incoming supplies. By 1916, Canada was leading the world in wheat exports. Twenty-five years later, 60% of the Prairie Ecozone was under cultivation and the landscape resembled a checkerboard.

In 1936, farmers represented 50% of the population. Today that number has fallen to less than 10%. Population decline in the rural areas and growth in the urban areas has been the general rule since the 1950s. Although urban use of land is tiny in terms of area (0.3%), it remains an important influence on the ecozone. Today, the proportion of the urban population is 81% compared with 76% for all of Canada, a remarkable figure given that agricultural activities dominate the landscape of this ecozone. In 1991, the total population of the Prairie Ecozone was approximately 3.8 million, an increase of 25% since 1971. The major population centres are Calgary, Edmonton, Regina, Saskatoon and Winnipeg.

The economic structure of the ecozone reflects a dependence on the primary industries of agriculture, mining, and gas and oil extraction. The Prairies provide 19% of Canada's total resource-based employment, with agricultural activities and food processing accounting for nearly 62% of the total. Its minerals industry (fossil fuels and related products) accounts for nearly a third of Canada's total employment in this sector. In 1991, the Prairie Ecozone had an estimated Gross Domestic Product of roughly $91 billion, representing about 15% of Canada's total GDP.

The Prairie ecozone has been farmed with a limited variety of crops. Only 15 field crops (grain, oilseeds, and pulses) and even fewer forage crops occupy more than 95% of the cropped area. With the exception of canola, which has recently surpassed wheat in the amount of area seeded, these crops have been the mainstay of production since European settlement. Beef and dairy cattle, swine, horses, chickens, and turkeys are the primary domesticated animals.

Mining, particularly the production of fuels, is the second most important industry. Although the value of mineral production increased in both Saskatchewan and Alberta between 1976 and 1991, land use for oil production has declined over the past decade, reflecting changes in world prices and incentives for exploration and development. By 1991, the value of mineral production in the Alberta portion of the ecozone made up 46% of Canada's total mineral activity.

The Prairie economy is now shifting from primary and secondary industries toward service-based sectors. The primary and secondary industries are geared mainly at processing food, wood, metals, chemicals, and petrochemicals. In the 1980s, agriculture generated about $5 billion, or 25% of all exports from the region. This accounted for 2% of global grain, rice and vegetable oil output. Mineral and fossil fuel exploitation and other goods and services generate $15 billion annually.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995. An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996. An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996. A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996. Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

13. GREAT PLAINS

FURTHER READING

Alberta, Environmental Protection. 1995. Alberta's State of the Environment Comprehensive Report. Alberta, Environmental Protection. Edmonton, Alta. ISBN 0-7732-1412-7.

Caza, C. and A. Käärik, eds. 1994. Envisioning Future Canadian Landscapes: A Source Book. Wildlife Habitat Canada, North American Waterfowl Management Plan. Ottawa, Ont. ISBN 0-921-553-14-5.

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Manitoba Environment. 1995. State of the Environment Report for Manitoba. Manitoba Environment. Winnipeg, Man. ISBN 0-771-1452-4.

Morrison, I. and D. Kraft, eds. 1994. Sustainability of Canada's Agri-Food System: A Prairie Perspective. International Institute for Sustainable Development. Winnipeg, Man. ISBN I-895536-22-7.

Saskatchewan Environment and Resource Management. 1995. Saskatchewan's State of the Environment Report 1995. Government of Saskatchewan. Regina, Sask.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series. No. 19. Environment Canada Ottawa, Ont. ISBN0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Autumn Downey, Yellowknife, who provided watercolour reproductions.

Most of the text was written by Environment Canada staff – Ed Wiken, V. Neimanis, Ian Marshall, Wayne Bond and many others. David Gauthier of the Canadian Plains Research Center was particularly helpful. Some material was supplied under contract by CYGNUS Environmental Consulting (Jamie Bastedo). Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

CANADIAN PLAINS RESEARCH CENTER

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada

ATLANTIC HIGHLANDS

Atlantic Maritime Ecozone

Mixed-wood Acadian forests, sand dunes stretched along seaboards, and coastal islands are some of the unique ecosystems of the Atlantic Maritime Ecozone. It extends from the Gaspé Peninsula at the mouth of the St. Lawrence River southwest through Quebec to the U.S. border south of Sherbrooke. It also includes the three maritime provinces of Prince Edward Island, Nova Scotia, and New Brunswick.

The harvesting of forests was made possible after the end of the last ice age 10,000 years ago. As the climate continued to moderate, southern temperate vegetation migrated north, merged with existing boreal forests, and spread as the unique mixed-wood forest now characteristic of much of the area. The ecozone's forests have contributed to the development of a distinctive Atlantic Canadian way of life since the area was first settled.

Where tidal mixing and upwelling of deep nutrient-rich waters occur, excellent finfish and lobster fisheries have prospered. Fishing has traditionally played a pivotal role in the ecozone's history. Today, it is threatened by a diminishing resource base, and aquaculture, mining, and tourism are the preferred alternatives.

History of human settlement within the Atlantic Maritime Ecozone is intimately linked to its coastline. Both the Mi'kmaqs and Maliseet aboriginal populations, who once inhabiting most of the ecozone, relied upon coasts and major waterways for transportation, food, and recreation. The first Europeans to arrive in Atlantic Canada in the 17th century settled in coastal lowlands with promising harbours.

The ecozone saw frequent battles over natural resources. Control was passed from the Mi'kmaq-Maliseet to the French, then to dual sovereignty of France and Britain in 1713, and eventually to the British in 1763.

1. *Frequent showers*
2. *Cloud cover/fog*
3. *Coastal lowland*
4. *Rough upland*
5. *Ocean*
6. *Peninsula*
7. *Wetland*

LANDFORMS AND CLIMATE

The Atlantic Maritime Ecozone constitutes a cluster of peninsulas and islands which form the northeastern end of the Appalachian mountain chain that runs from Newfoundland to Alabama. The highest point, Mount Carleton in New Brunswick, reaches 807 metres and offers a magnificent view. In the uplands, repeated glaciation has produced shallow, stony soils, and outcrops composed of granite, gneiss, and other hard, crystalline rocks. Rough upland terrain and poor soils are often unsuitable for farming and have discouraged extensive settlement. The inhospitable highlands feature cold, wet climates and acidic soils, but yield vast forests.

Coastal lowlands of the Northumberland Plain accommodate the greater share of the population and agricultural activities. Here, deeper soils are traced to marine deposition and glacial erosion of underlying sandstone, shale, and limestone bedrock. With the exception of P.E.I., abrupt transitions between uplands and lowland basins mark much of the ecozone's landscape. The majority of the ecozone is overlaid by nutrient-poor Podzol soil and better-quality grey-brown Luvisol soils.

Numerous lakes speckle rugged regions of igneous rock, such as volcanics and granite, which are covered by a thin layer of soil. Rivers and streams predominate in areas of sedimentary bedrock and thicker soils. Over 11 000 kilometres of coastline are deeply indented by tidal inlets and impressive sand dunes. Almost 4 000 offshore islands dotted with lagoons and extensive marshes ring Nova Scotia. Red sandstone cliffs and hard volcanic rocks in the Bay of Fundy tower over intertidal beaches up to 5 kilometres wide.

The proximity of the Atlantic ocean creates a moderate, cool, and moist maritime climate. Most of the ecozone experiences long, mild winters (averaging about -4°C in January) and cool summers (the mean daily July temperature is 18°C). Coastal communities are generally several degrees warmer in winter and slightly cooler in summer.

During late spring and early summer, the mixing of the cold Labrador Current and the warm Gulf Stream produces frequent banks of sea fog over coastal areas. Average precipitation varies from 1 000 mm inland to 1 425 mm along the coast. The average annual growing season ranges from 1 500 to over 1 750 growing degree days above 5°C. Frost-free days, on average, fluctuate from 80 in the New Brunswick highlands to 180 along the coast. With a storm frequency higher than anywhere else in Canada, sunshine can be a rare commodity.

1. *Black/Red Spruce*
2. *Dead Maple*
3. *Violets*
4. *Wild Lupens*
5. *Balsam Fir*
6. *Starflower*
7. *Marsh grasses*

PLANTS

Centuries of forestry, agriculture, and natural disturbances have left few pockets of old-growth forest. Today, forests are predominantly secondary and tertiary growth on old clear-cuts and abandoned farms. Decades of logging are also responsible for habitat destruction, soil erosion, and increased nutrient loss.

The Atlantic Maritime Ecozone ranks as the third most forested ecozone with 76% of its surface area covered with forests, which are divided into three distinct regions: Boreal, Great Lakes-St. Lawrence, and Acadian. The Boreal region, associated with fir and spruce, stretches from the northwestern tip of New Brunswick into the Gaspé Peninsula. Eastern White Pine, Red Pine, Yellow Birch, and Eastern Hemlock typify the relatively small Great Lakes-St. Lawrence region of northern New Brunswick. Acadian forests, covering 44% of the entire ecozone, are characterized by a mixture of coniferous and deciduous species. Hardwoods, such as Sugar Maple, Beech, and Yellow Birch, dominate shallow but well-drained slopes and hillsides. Conifers, especially Red Spruce, are concentrated in moist soils, coastal fringes, and areas recovering from disturbances. All three regions are interlaced with numerous lakes and wetlands.

Moss, lichen, ferns, and heathers are typical of swampy areas and rocky barrens. Seaweed and kelp grow along exposed coastlines. Acadian forests are decorated with wildflowers such as Trailing Arbutus, Lady Slipper, Pitcher Plant, and several varieties of violets. The Ostrich Fern, harvested for its fiddlehead in the spring, thrives on deciduous-covered streambanks in New Brunswick and Nova Scotia. Blueberry, Pin Cherry, and Speckled Alder are also common. The Purple Loosestrife, an introduced species, has proliferated and displaced many native wetland species.

At least 10 plants are recognized as either endangered or threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The endangered Water-pennywort, a small creeping species of tropical origin, is limited to two localities in southeastern Nova Scotia.Cottage development and recreational activities have placed the Water-pennywort at risk. The Furbish's Lousewort grows exclusively along a 200-kilometre stretch of the Upper Saint John River in New Brunswick. Habitat destruction due to farming, forestry, and flooding from hydro-electric development has put the Furbish's Lousewort on the endangered list.

The Spruce Budworm has significantly influenced the ecozone's forests. The most recent outbreak, beginning in the late 1960s, either destroyed or severely damaged large expanses of spruce forests. Fortunately, the budworm population has collapsed since 1991 in all but northern New Brunswick. Other species, such as Jack Pine, have taken advantage of the blight, forest fires, and other disturbances.

1. *Herring Gull*
2. *Mallard*
3. *Moose*
4. *Beaver*
5. *Black Bear*
6. *Red-winged Blackbird*
7. *Whitetail Deer*
8. *Eastern Bluebird*
9. *Blue Jay*
10. *Raccoon*
11. *Blue Whale*
12. *Cardinal*

WILDLIFE

Although the ecozone represents only 2% of Canada, it embraces a wide variety of critical terrestrial, freshwater, and marine environments. Kelp and seaweed along rocky coasts provide shelter and food for various marine communities of mussels and crab. The Scotian Shelf off Nova Scotia is one of the most productive offshore areas in the ecozone. Low-lying beaches and tidal flats of the Upper Bay of Fundy and the southern Gulf of St. Lawrence are dominated by burrowing crustaceans. The Gulf is well-known for its scallop, mackerel, groundfish, and herring fisheries. Seals, dolphins, porpoises and Black Guillemots are among the higher predators within the ecozone. Both seal-and whale-watching are popular tourist attractions.

Rivers draining the area are vital for the commercially important Atlantic Salmon and other ocean fish that return to inland streams to spawn. Brook Trout, Gaspereau, Halibut, and Bass are highly valued by recreational and commercial fishers.

Lakes and shaded waterways within forests supply habitat for herons, loons, and freshwater ducks, while osprey and eagles nest in tall trees. Canada Goose, Blue-winged Teal, Ring-necked Duck, and 31 other bird species breed exclusively in the unique freshwater habitats of the Atlantic region. Tens of thousands of shore and migratory birds feed on crustaceans in the tidal mudflats of the Bay of Fundy. With productiveseas and substantial coastal estuaries, the Atlantic Maritime Ecozone is often referred to as "an international crossroads for seabirds."

Much of the ecozone's wildlife is dependent on forest ecosystems. Terrestrial mammals include Black Bear, Bobcat, Snowshoe Hare, Northern Flying Squirrel, and White-tailed Deer. Large moose herds concentrate in various regions, especially in the heart of the Chics-Chocs mountains of the Gaspé Peninsula. Wolves, Mink, and the occasional Lynx also reside in the ecozone.

Alteration and loss of habitat from human activities are the greatest threat to wildlife. Fragmented landscapes and species decline can be attributed to logging, agriculture, overfishing, and urbanization. The Grey Whale has disappeared from the Atlantic after centuries of hunting. The endangered status of the Acadian Whitefish is the result of overfishing and water quality degradation from acid rain and other contaminants. The threatened Roseate Tern's feathers were exploited by the fashion trade of the 19th and early 20th centuries. Today, the species is challenged by expanding Herring Gull populations preying on its eggs and chicks.

Many initiatives have been taken to preserve the ecozone's unique fauna. Provincial regulations and protected areas help maintain species and habitat. Machias Seal Island, a migratory bird sanctuary in the Bay of Fundy, is home to the only colonies of the Atlantic Puffin and Razorbill in New Brunswick. Several species also seek refuge in the ecozone's six national parks. The threatened Blanding's Turtle population, for example, is almost exclusively confined to acidic waters and peaty soils within Kejimkujik National Park.

1. *Whale-watching*
2. *Fishing*
3. *Lobster fishing*
4. *Lumbering*
5. *Small village*
6. *Historical site*
7. *Navigational aid*
8. *Small farm*
9. *Tourism*

HUMAN ACTIVITIES

No single resource has influenced socio-economic development in the Atlantic Maritime Ecozone more than fish. For 500 years the seas off Atlantic Canada were one of the world's richest commercial fisheries. Traditional fisheries focused on groundfish: Cod, Pollock, Haddock, Plaice, and, closer to shore, Mackerel. Modern fishing technology led to new heights in the number of ships and catch levels. The Northern Cod catch rose from about 200 000 tonnes to 300 000 tonnes a year between 1850 and 1950. With the introduction of foreign fleets, the annual catch in thenorthwest Atlantic climbed to a peak of 800 000 tonnes by the late 1960s. A drastic decline to 200 000 tonnes a year in the 1970s was followed by a catastrophic collapse in the 1980s. The collapse of the groundfish industry is the result of a diminishing resource base and severe environmental pressure.

Traditional fishing-dependent communities now face many challenges. Aquaculture, or fish farming, may compensate for some of the economic setbacks. This new and expanding industry often employs former fishers and helps satisfy a world-wide demand for high-quality fish products. Today, aquaculture concentrates primarily on finfish, such as Atlantic Salmon, and various shellfish, such as Blue Mussel, Oyster, and Lobster. In 1993, P.E.I. alone exported nearly 4 500 tonnes of cultured mussels, worth almost $10 million.

A relatively short, cool growing season and mediocre soils have hampered farming in many regions. Specialized potato farms on fertile lowland soils throughout most of P.E.I. and northwestern New Brunswick, along with prosperous fruit orchards in the Annapolis-Cornwallis Valley of Nova Scotia, are two exceptions. In 1991, agriculture accounted for 31% of total resource-based employment. Although less land area is farmed today, that which remains is used more intensively. In fact, only 8.7% of the ecozone's surface cover area is now classified as agricultural cropland.

Both forestry and tourism contribute significantly to the ecozone's economy. The 1991 forestry and forest products labour force consisted of some 48 000 workers. The ecozone's economically strong pulp and paper industry uses roughly 65% of the total volume of wood harvested. Naturally scenic landscapes are principal attractions for tourists. Places of interest include Cape Breton Island and its celebrated Cabot Trail, and the Bay of Fundy, which features 16 metre tides, the world's highest. Hiking, birdwatching, and photography are popular ecotourism activities.

The Atlantic Maritime Ecozone had an estimated 1991 Gross Domestic Product of approximately $40 billion, contributing 7% of Canada's total. The ecozone provides 12% of Canada's total resource-based employment, with the fishery and fish products sector accounting for 25% of this total.

Home to over 2 5 million people in 1991, the ecozone represents 9% of Canada's population and 6% of its urban population. Contrary to most ecozones, more people live in rural areas than cities. Today, the urban population sits at 49%, significantly less than the national average of 76%. Halifax represents the largest metropolitan area, with 320 000 residents in 1991. Small fishing villages and resource-dependent communities hugging coastlines are more commonplace than large urban centres.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km^2). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km^2) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

14. ATLANTIC HIGHLANDS

FURTHER READING

Brown, P. 1990. Report Development and Sustainability: A Sectoral Analysis of the Atlantic Economy. Environment Canada. Dartmouth, N.S.

Cognetti, G., and M. Curini-Galleti. 1993. Biodiversity Conservation Problems in the Marine Environment. Marine Pollution Bulletin, Vol. 26, No. 4, April 1993: 179-183.

Eaton, P.B., A.G. Gray, P.W. Johnson, and E. Hundert. 1994. State of the Environment in the Atlantic Region. Environment Canada, Atlantic Region. ISBN 0-662-20520-0.

Government of Canada. 1991. The State of Canada's Environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Macpherson, A.G., ed. 1972. Studies in Canadian Geography: The Atlantic Provinces. University of Toronto Press. Toronto, Ont. ISBN 0-8020-6158-3.

Stephenson, R.L. 1990. Multi-use conflict. World Aquaculture, Vol. 21(2): 34-45

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series. No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1996), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by William J. Johnson of Fine Art Studio, London, Ont.

Most of the text was written by Environment Canada staff – Ed Wiken, Harry Hirvonen, Neville Ward, John Reid, Ian Marshall, Wayne Bond and many others. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

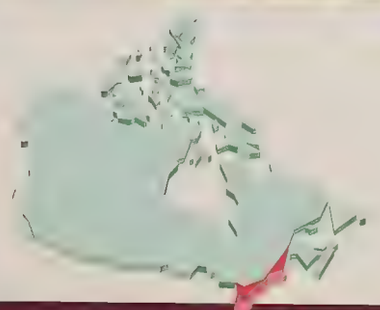
Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada



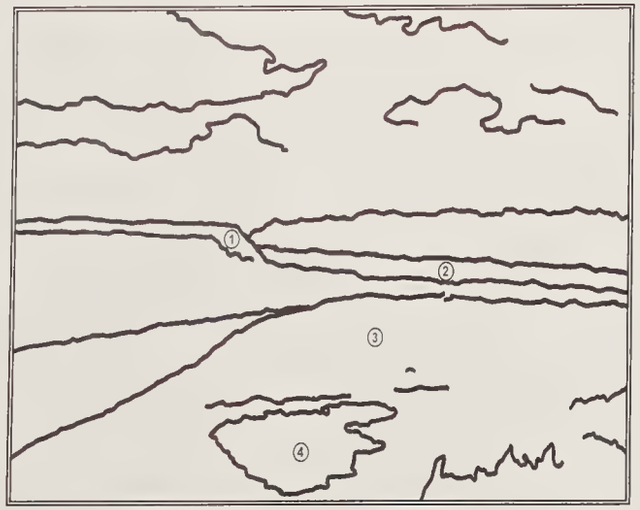
THE URBAN CORRIDOR

Mixedwood Plains Ecozone

An extensive system of waterways, including the St. Lawrence River and the Great Lakes, combines with surrounding rich fertile soils to create one of the most attractive and productive ecozones in Canada. The Mixedwood Plains Ecozone, encompassing a small area of 175 963 square kilometres, is bounded by three Great Lakes in southern Ontario and extends along the St. Lawrence shoreline to Quebec City. With its relatively mild climate, it represents the most populous and prosperous terrestrial ecozone.

Native communities, including the Mohawk, Algonquian, Iroquoian, and Cree, inhabited the favoured Mixedwood Plains long before European settlement. The earliest French arrivals, also recognizing the St. Lawrence River's many advantages, established themselves along the shoreline at Quebec City in 1608, Trois-RiviPres in 1634, and Montreal in 1642. British settlers founded the towns of Niagara, Hamilton, and Toronto in Upper Canada during the mid-18th century.

Interlaced with national and international transportation routes, the Mixedwood Plains have become the industrial and commercial heartland of Canada. Urban centres encroach on remaining prime agricultural land as the population continues to grow. Settlement and resource extraction dramatically alter the land. Striking a balance between economic development and ecological sustainability has become a challenge for today's residents and for future generations.



1. *Waterfall*
2. *River*
3. *Plain*
4. *Wetlands*

LANDFORMS AND CLIMATE

Until the most recent continental ice sheet retreated 11 000 years ago, the Mixedwood Plains Ecozone was buried under more than a kilometre of ice. Following the ice age, the St. Lawrence and lower Ottawa valleys were covered by the Champlain Sea for another 1 200 years. Thick marine clay deposits in southern and southeastern Ontario and southwestern Quebec are the products of glacial action and the now extinct Champlain Sea. Beneath the urban centres and agricultural fields are mesozoic andpaleozoic sedimentary rock.

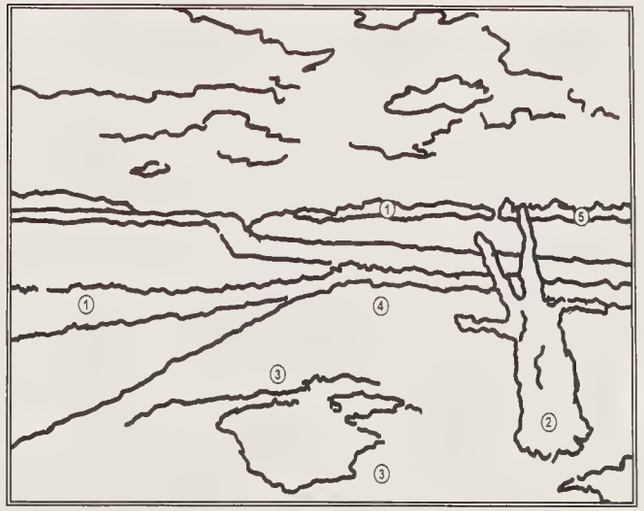
Striking physical features break up the otherwise nearly level to gently rolling plains of most of the ecozone. One of the most prominent is the Niagara Escarpment from Niagara Falls to the northern tip of the Bruce Peninsula and Manitoulin Island.

Limestone, shale, and sandstone are characteristic of the flat-lying St. Lawrence lowlands. Mount Royal rises to 227 metres above sea level from the widest and flattest sections of the Montreal Plain. Some visually dominant landforms in the area are the St. Narcisse terminal moraine on the north side of the St. Lawrence River, and the Drummondville and Highland Front moraines of the south shore. Over 6 000 drumlins are scattered among the extensive sand and limestone plains in the ecozone's southern stretches between lakes Huron, Ontario, and Erie.

The Mixedwood Plains Ecozone is endowed with abundant freshwater resources, including four of the Great Lakes – Superior, Huron, Erie, and Ontario – and the St. Lawrence River from Kingston to Quebec City. These Great Lakes constitute nearly 20% of the world's fresh water. The outflow of the St. Lawrence is the greatest of any river in Canada and ranks thirteenth worldwide. Tributaries, such as the Ottawa, Maurice, and Saguenay, bolster the river's flow along its 600-kilometre route to the gulf. Rivers and lakes occupy roughly 42% of the ecozone's total surface cover.

Variations in climate, vegetation, and soils influence the land-use patterns. Podzol soils in northern stretches, while generally useless for agriculture, are suited to forestry and recreation. In the south, grey-brown Luvisol soils, developed under forest vegetation from glacial deposits, are favoured for agricultural crops such as tobacco and fruit.

The climate of the Mixedwood Plains produces relatively warm summers and cool winters moderated by surrounding water bodies. Mean daily January temperatures range from -3°C to -12°C, whereas mean daily July temperatures are 18°C to 22°C. The ecozone supports a wide variety of agricultural activities with an average annual growing season, north to south, ranging from 1 750 to 2 500 growing degree days above 5°C. This region also receives 720 to 1 000 mm of precipitation annually. Due to its location in the midst of a significant North American storm belt, weather in the Mixedwood Plains can change rapidly. Several southern cities, such as Woodstock and Guelph, receive considerable amounts of snow.



1. *Mixed forest*
2. *Maple*
3. *Sedges and moss*
4. *Meadow grasses*
5. *White Pine*

PLANTS

Vast tracks of forest once blanketed most of the Mixedwood Plains. Areas to the north and east of Toronto were covered in the Great Lakes-St. Lawrence forest region, characterized by Eastern White Pine, Eastern Hemlock, Yellow Birch, and Red Pine. An abundance of broad-leaved species, such as Sugar Maple, Red Oak, Basswood, and White Elm, were also widely distributed throughout the area. A small portion of the deciduous, or Carolinian, forest region reaches its northern limits in southwestern Ontario between lakes Huron, Erie, and Ontario. Tulip-tree, Blue Ash, Red Mulberry, and Kentucky Coffee-tree are confined largely to the warmest portions of the ecozone. These unique deciduous forests are intermixed with Black Walnut, Sycamore, and the more common Great Lakes-St. Lawrence forest species.

Very little of the original forest remains today. Centuries of agriculture, logging, and urbanization in particular, fragmented the landscape into isolated pockets of forest. In Ontario, many of these pockets are now farms, woodlots, urban forests, or protected areas. Heavily forested areas are, however, more common around the northern lakes. Presently, the ecozone's forests consist of 12.8% mixedwood, 2.1% deciduous, and 0.2% coniferous trees.

Even though the Mixedwood Plains represent Canada's smallest terrestrial ecozone, they contain over half the nation's endangered and threatened species. The American Ginseng, designated as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), inhabits rich moist deciduous forests in southwestern Quebec and southern Ontario. Populations have been drastically reduced by excessive cattle grazing, logging, and the commercial harvest of its roots. In the late 1980s the Blue-eyed Mary disappeared from open woodland sites along waterways in south-central Ontario.

Influenced by the surrounding Great Lakes and tropical air from the Gulf of Mexico, the Carolinian forests are home to a unique combination of plants and wildlife. Stretching from Windsor in the west to the eastern border of Metropolitan Toronto, this zone represents one of Canada's mostvulnerable ecosystems. Today, forest cover ranges from a mere 3 to 16%, and 40% of Ontario's rare plants are restricted to the region. Endangered species include the Prickly Pear Cactus, Small-whorled Pogonia, Cucumber Tree, and Wood Poppy.

Today's forest ecosystems are decorated with vibrant wildflowers and shrubs. Trilliums, Clover, Black-eyed Susans, Goldenrod, and Wild Raspberry are common. Thickets and abandoned fields give rise to successional species such as Staghorn Sumac, Highbush Cranberry, Red-osier Dogwood, and Willow. Various aquatic species inhabit the few remaining wetlands in the Great Lakes Basin and along the shorelines of Lake St. Clair, Lake Erie, and the St. Lawrence River. Native and exotic plants, such as cattails, water lilies, sedges, and Purple Loosestrife, can be found in wetlands as well.

1. *Canada Geese*
2. *Mallard*
3. *Whitetail Deer*
4. *Fox*
5. *Black Bear*
6. *Chipmunk*
7. *Raccoon*
8. *Grey Squirrel*
9. *Blue Jay*
10. *Striped Skunk*
11. *Short-billed Dowitcher*

WILDLIFE

The Great Lakes and St. Lawrence River were primary attractions for early settlers to the Mixedwood Plains, and not only as a travel route. The waterways supported a tremendous wealth of fish and other aquatic species that stimulated economic growth and regional development. The Great Lakes were once dominated by large, bottom-dwelling species such as Lake Trout, Whitefish, and Sturgeon. Walleye and Largemouth Bass flourished in sheltered bays and the warm, shallow Lake Erie.

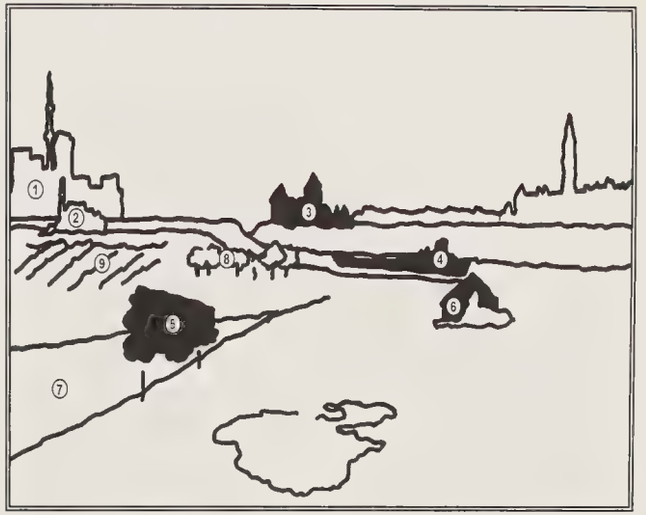
For decades aquatic communities have suffered from the effects of intense commercial fishing and habitat destruction. Many spawning and feeding areas have been lost to siltation, pollution, and dredging. Centuries of overfishing forced the Great Lakes commercial fisheries to focus primarily on introduced non-native species, such as Rainbow Smelt, White Perch, and Common Carp. Today the St. Lawrence River and its marine habitats support a diverse collection of aquatic species, including Atlantic Tomcod, Northern Pike, baleen whales and the endangered Beluga Whale.

The introduction of various exotic species is also responsible for serious economic and ecological damage. Both the Sea Lamprey and Zebra Mussel, for example, have dramatically altered aquatic ecosystems. The Zebra Mussel, aggressively spreading through most of the ecozone's waterways since 1986, has disrupted food chains by reducing phytoplankton and zooplankton populations.

Numerous bird species, including the Cardinal, Green Heron, and Carolina Wren, are unique to the Mixedwood Plains Ecozone. Typical residents of remnant forest patches and urban greenspace include Blue Jay, Whip-poor-will, Red-headed Woodpecker, and Baltimore Oriole populations. The Long Point Biosphere reserve in southern Ontario now plays a vital continental role in the protection of migratory bird habitat. Attracted to extensive marshes for staging and overwintering purposes, roughly 280 bird species have been banded in the region since 1960. For the Henslow's Sparrow, however, habitat protection has been minimal. A native to meadows and abandoned agricultural fields in southern Ontario, the sparrow was declared endangered by COSEWIC in 1993. Long-term population declines are related to intense cultivation and urban sprawl.

Two of the three reptiles listed as threatened by COSEWIC reside within the Mixedwood Plains ecozone. The eastern Massasauga Rattlesnake, commonly perceived as dangerous, is restricted to diminishing wetlands in Ontario. Stretches of the St. Lawrence River, as well as lakes St. Clair, Erie, Ontario, and Champlain, are home to the increasingly rare Spiny Softshell Turtle.

Forests and grasslands support a wide variety of terrestrial organisms in the Mixedwood Plains. Characteristic mammals include White-tailed Deer, Black Bear, eastern Cottontail, and Grey and Black Squirrels. Foxes and wolves make appearances outside urban settings, while coastal wetlands and tributaries provide crucial habitat for beaver and muskrat. Although many species have lost varying degrees of habitat to urban expansion, a handful have proved resilient. Nuisance animals, such as raccoons, house mice, and groundhogs, have found special niches within urban ecosystems and thrive there.



1. *Cityscape*
2. *Power Station*
3. *Tourism*
4. *Shipping*
5. *Forestry*
6. *Farming*
7. *Transportation*
8. *Orchard*
9. *Vineyard*

HUMAN ACTIVITIES

Most human activities in the Mixedwood Plains Ecozone, both past and present, are associated with urbanization. Containing 52% of Canada's 1991 population, it is the most densely populated ecozone in the country. Of the nation's 25 largest cities, 13 fall within the ecozone. The largest– Toronto, Montreal, Ottawa, and Quebec City – are connected by extensive networks of expressways. Between 1966 and 1991, Toronto's population grew by 80%, and the Toronto metropolitan area now houses 14% of all Canadians, compared with 11.5% living in the Montreal area.

Even though 85% of residents live in urban areas, settlement patterns have changed from the traditional compact, centralized city to new suburbs spreading into surrounding countryside. Smaller cities are no exception. Kitchener-Waterloo, for example, grew by 57% between 1971 and 1991. Several outlying municipalities north and east of Montreal, such as St-Lazare and Blainville, also grew by over 40% from 1986 to 1991. Home to 11 million people in 1971, the entire ecozone supported 14 million just two decades later.

Intensive urban development in the Mixedwood Plains has led to severe environmental degradation. Relocation to the suburbs and urban fringe escalated dependency on private automobiles. Consequently, residents in the Windsor-Quebec City corridor now breathe some of the highest levels of air pollutants, including ground-level ozone and suspended particulates.

The Mixedwood Plains had an estimated Gross Domestic Product in 1991 of $325 billion, contributing 55% of Canada's total. The ecozone provides 34% of Canada's resource-based employment, and half of that number work in the agriculture and food industry. The ecozone's service industry, constituting a third of the labour force, is immensely important to national and international trade and commerce. Oil refineries, power-line corridors and industrial parks dotting vast tracts of the landscape are evidence of the ecozone's dominant service and manufacturing industries.

Fertile soils and a relatively mild climate have created excellent agricultural land in the Mixedwood Plains. In fact, the ecozone contains over 50% of Canada's class 1 agricultural land, and 62% of the land with a capability of classes 1, 2, and 3. The Niagara Peninsula, famous for its fruit orchards and vineyards, is the warmest and most intensively cultivated part of the ecozone. Corn, soybeans, and specialty crops such as tobacco and vegetables are concentrated in southern regions enjoying 2 000 to 2 500 growing degree days. The cultivation of mixed grains also enhances hog, dairy, and beef livestock production throughout the ecozone. Today, urban expansion is the primary reason for loss of prime agricultural land.

Tourism and recreation continue to strengthen the Mixedwood Plains' economy. The spectacular Niagara Falls, CN Tower in Toronto, and the historic cities of Montreal and Quebec are a few of the many popular tourist attractions. Numerous northern communities, once heavily dependent on logging and mining, have turned to tourism for additional sources of revenue. Cottage development along the Great Lakes and St. Lawrence shorelines has intensified as urban residents spend more of their leisure time beyond city limits. Marinas, resorts, and restaurants are now common sites in the countryside.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

15. THE URBAN CORRIDOR

FURTHER READING

Allardice, D.R., and S. Thorp. 1995. A changing Great Lakes economy: economic and environmental linkages. State of the Lakes Ecosystem Conference. Environment Canada and United States Environmental Protection Agency. Burlington, Ont.

Bouchard, H. and P. Millet. 1993. The St. Lawrence River: diversified environments. St. Lawrence Update series. No. 97. Environment Canada, Quebec Region, State of the Environment Branch. St. Lawrence. Que.

Centre for Land and Water Stewardship. 1994. Appreciating the uniqueness of Carolinian Canada. Carolinian Canada. Factsheet 1. University of Guelph, Ontario, The Centre for Land and Water Stewardship. Guelph, Ont.

Government of Canada. 1991. The State of Canada's environment. Minister of Supply and Services Canada. Ottawa, Ont. ISBN 0-660-14237-6.

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Metro Toronto and Region Remedial Action Plan. 1994. Clean waters, clear choices. Recommendations for action. Ontario Ministry of the Environmentand Energy, Metro Toronto and Region Remedial Action Plan. Toronto, Ont.

Sly, P.G. 1991. The effects of land use and cultural developments on the Lake Ontario ecosystem since 1750. Hydrobiologia 213:1-75.

United States Environmental Protection Agency and Environment Canada. 1988. The Great Lakes: An environmental atlas and resource book. Environment Canada. Toronto, Ont. ISBN 0-662-15189-5.

Wiken, E.B. 1986. Terrestrial ecozones of Canada. Ecological Land Classification Series. No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by William J. Johnson of Fine Art Studio, London, Ont.

Most of the text was written by Environment Canada staff – Ed Wiken,Christian Pupp, Wayne Bond, John Reid, Ian Marshall, V. Neimanis and many others. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

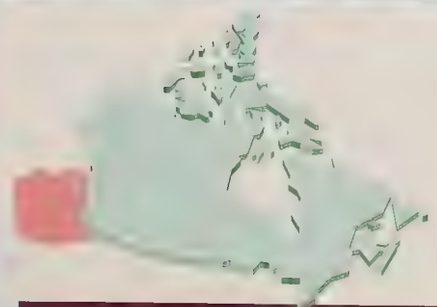
Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada

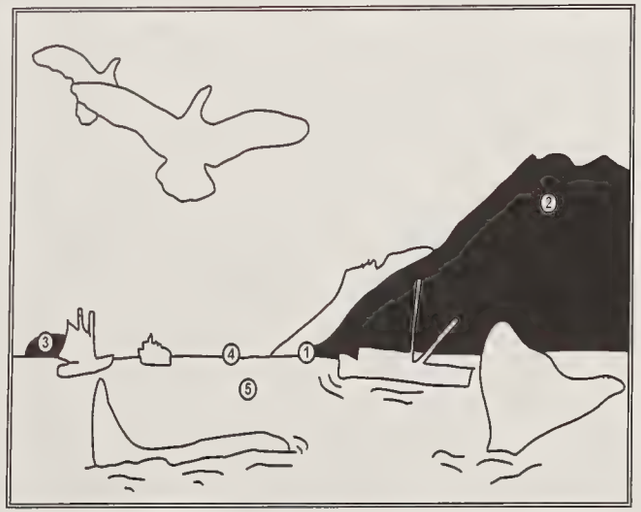


PACIFIC RIM

Pacific Marine Ecozone

The waters of the Pacific Coast are best known to Canadians today for their popular tourism destinations and the prominent, though troubled, fishing industry. But the Pacific coast of British Columbia is also home to ancient indigenous cultures. On his famous third voyage around the world in 1778, Captain James Cook became the first known European to reach the Pacific coast of present-day B. C. There he encountered the ancient communities of the "People of the Totem," who had been living on the coast and in the Queen Charlotte Islands for at least 8 000 years. The heavily forested and mountainous terrain led to the emergence of a sea-dependent culture and the people of the Pacific coast acquired sea-faring and fishing skills superior to those of the first European explorers. The Haida in particular had a reputation for undertaking long, perilous sea voyages.

The Pacific Marine Ecozone is home to abundant plant and wildlife, but also has one of the fastest growing human populations in North America. The ecozone extends from the southern tip of Vancouver Island to Dixon Entrance, north of the Queen Charlotte Islands. Ignoring international boundaries, it actually reaches as far north as Alaska and the Bering Sea and south to the coasts of the states of Washington and Oregon.



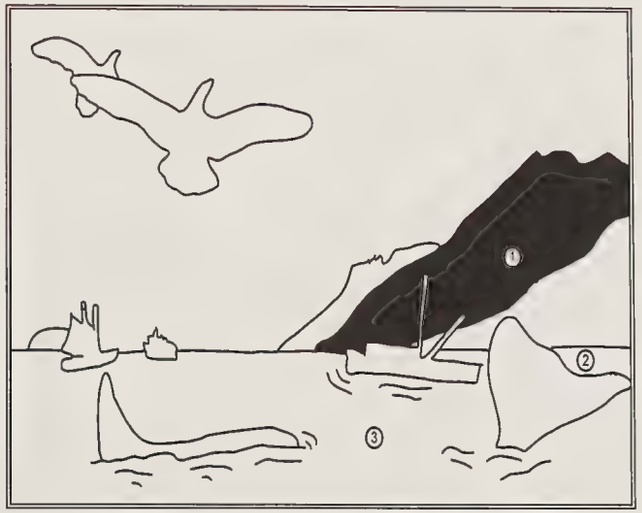
1. *Fjord inlet*
2. *Coastal mountains*
3. *Coastal island*
4. *Coastal passage*
5. *Ocean*

LANDFORMS AND CLIMATE

The ecozone takes in all of Canada's fjord-dominated west coast and runs out to sea over a narrow continental shelf and slope. The shelf lies beneath the entire ecozone and is the leading edge of the great North American tectonic plate. As the plate drifts almost imperceptibly westward, the shelf is folding under the Pacific tectonic plate, which forms the bottom of much of the Pacific Ocean. Massive geological forces at work where the shelves meet cause undersea volcanoes and the famous west coast earthquakes.

Unlike the Arctic and Atlantic ecozones, sea ice is generally absent from the Pacific Marine Ecozone. The land barrier imposed by the Alaskan peninsula prevents much of the cold arctic currents from flowing down the west coast, so there is little oceanic water exchanged between the Arctic and Pacific ecozones. From south to north within Canada's borders, ocean surface temperatures in the ecozone at any one time vary only about 3°C, while seasonal ocean temperatures vary within a narrow range of about 7°C, a striking contrast to the 20°C variation of the east coast.

Based on its stable temperatures, the Pacific Marine Ecozone may be considered a transition zone between the polar seas of the Arctic and the temperate waters of the mid-latitude Pacific Ocean. Ice occurs only seasonally, and then only outside Canada's territorial waters at the northern boundary of the Bering Sea, the Sea of Okhotsk, and in bays and inlets where there are considerable flows of fresh water off the land.

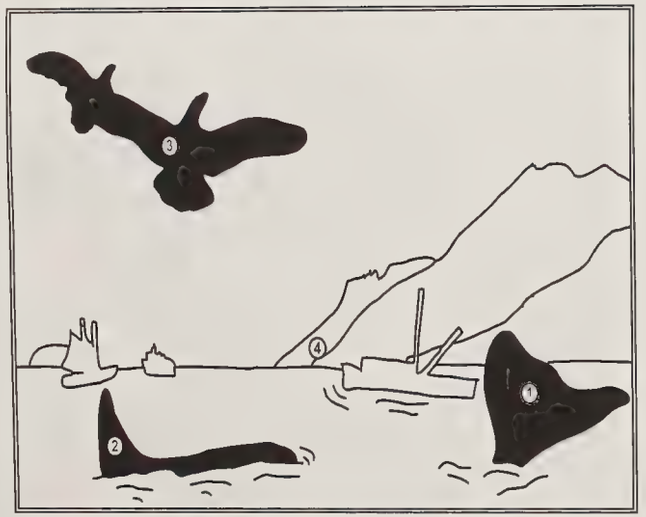


1. *Coastal forest*
2. *Kelp beds*
3. *Ocean plankton*

PLANTS

Throughout the ecozone, freshwater discharges from the Fraser, Skeena, Nass, and other rivers carry vast amounts of nutrients to the ocean, stimulating the growth of phytoplankton, algae, and other marine plant life. Near the southern end of Vancouver Island, deep water upwelling encourages a prolific ocean ecosystem. Unlike its Atlantic counterpart, the Pacific Marine Ecozone has little physical connection with the Arctic, so it has different populations and distributions of species such as plankton. In the intertidal zones (between high and low tide and always underwater) lie vast forests of Macrocystis, or Giant Kelp, along with several varieties of seaweed and coral reefs.

Soon after records of Captain Cook's voyages were published in 1784, British and American fur traders sailed to the Pacific waters in search of sea otters. By the early 1930s, the Pacific population of sea otters had been extirpated. Sea urchin populations, once controlled by the otters, subsequently exploded, decimating many of the kelp forests and their associated algae communities. Today, re-introduced otter populations are rising and the kelp habitat may also recover. Along the water's edge, coastal salt marshes and mudflats contain large beds of eelgrass, important spawning sites for Pacific Herring schools.

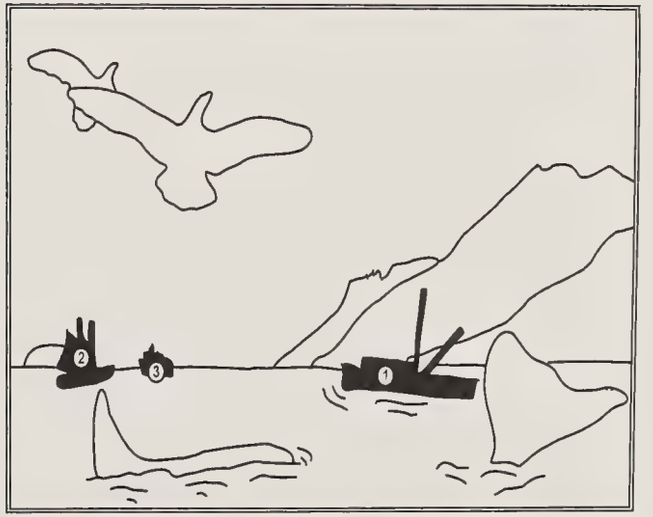


1. *Grey whale*
2. *Killer whale*
3. *Seagulls*
4. *Spawning stream*

WILDLIFE

The Pacific Marine Ecozone is home to about 3 800 species of invertebrates, a mixture of oceanic, subpolar, neritic (living in the tide waters and landwashes), and benthic (bottom-dwelling) plankton. These populations make up 3.5% of all marine invertebrates in the world. The large invertebrate populations provide rich food sources for the 220 species of fish living in the ecozone. The Pacific Herring is the most abundant, while Salmon, Halibut, Steelhead, and Dolly Varden, among others, form the backbone of commercial fisheries. Over the years, salmon and herring stocks have been overfished, and although herring stocks are rebounding, the health of salmon stocks remains questionable to many.

Marine mammals include Steller Sea Lions, Sea Otters, Northern Fur Seals, Orcas and Gray Whales. Large breeding bird populations include ducks and geese, Petrels, Guillemots, Murrelets and Auklets, with some Puffins and Murres. Several species of raptors, including Bald Eagles and Osprey, feed in the near-shore wetlands and rivers. All of the B. C. breeding populations of Brandt's Cormorants live on the west coast of Vancouver Island.



1. *Fishing boat*
2. *Sailing and recreation*
3. *Tourism, shipping*

HUMAN ACTIVITIES

The temperate climate, esthetically pleasing scenery, and often healthy economy make Canada's Pacific Coast a most desirable place to live. As a result, it is the fastest growing population centre in the country. By 2016, the population of greater Vancouver is expected to reach 5 million. Throughout the ecozone, fishing, shipping, tourism and marine recreation are the main human activities contributing to the area's high standard of living. But these lucrative and popular activities, along with pollution from ship traffic, urban run-off, destruction of shoreline habitat, and industrial pollution, are also in combination the main sources of ecological stress. In 1967, overfishing led to the collapse of herring stocks. Government restrictions allowed the stocks to rebuild and, by1993, most of the Pacific Herring stocks were in good condition. Today, salmon stocks are being overfished and continue to decline to dangerously low levels.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

16. PACIFIC RIM

FURTHER READING

Bancroft-Hunt, N. and Forman, W. People of the Totem. The Indians of the Pacific Northwest. Toronto: Doubleday Canada Limited. ISBN: 0-8061-2145-9

British Columbia Ministry of Environment, Lands and Parks; Government of Canada, 1993. State of the Environment Report for British Columbia. Victoria: Ministry of Environment, Lands and Parks; Vancouver: Environment Canada. ISBN 0-7726-1773-2

British Columbia/Washington Marine Science Panel. 1994. The Shared Marine Waters of British Columbia and Washington. Seattle: University of Washington. Vancouver: University of British Columbia.

Croom, M. M., Wolotira, R. J. and Henwood, W. 1992. Proposed biogeographic subdivision of the Northeast Pacific marine realm. Unpublished report submitted to IUCN, Lauzanne, Switzerland.

Government of Canada. 1996. The State of Canada's Environment-1996. EnvironmentCanada. Ottawa, Ont.

Government of Canada. 1991. The State of Canada's Environment. Ottawa: Minister of Supply and Services Canada. ISBN 0-660-14237-6

Government of Canada. 1994. A Marine Ecological Classification System for Canada. Draft Report. Marine Environmental Quality Advisory Group. Ottawa: Environment Canada.

Government of Canada. 1994. Sustaining Marine Resources: Pacific Herring Fish Stocks. Environmental Indicator Bulletin No. 94-5. Ottawa: Environment Canada. ISBN 0-662-22464-7

Government of Canada. 1995. Sea to Sea to Sea: Canada's National Marine Conservation System Plan. Department of Canadian Heritage. Ottawa: Minister of Supply and Services Canada. ISBN 0-662-23045-0. http://www.nap.edu/nap/online/salmon/summary.html

Lambert, P. 1994. Biodiversity of marine invertebrates of British Columbia. In Harding, L. E. and McCullum, E. (eds.). Biodiversity in British Columbia: our changing environment. Vancouver: Environment Canada.

Lower, J. A. 1970. A Nation Developing. A Brief History of Canada. Toronto: McGraw-Hill Ryerson. ISBN 0-7700-3208-7

National Academy of Sciences. 1995. Upstream: Salmon and Society in the Pacific Northwest.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Serge Bedard of Gatineau, Quebec.

Most of the text was written by Environment Canada staff – Ed Wiken, Harry Hirvonen, Ian Marshall and many others – and some of the work was written under contract to Kenneth Lawton Communications. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

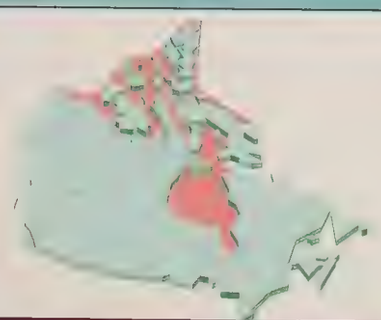
Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

Environment Canada Environnement Canada



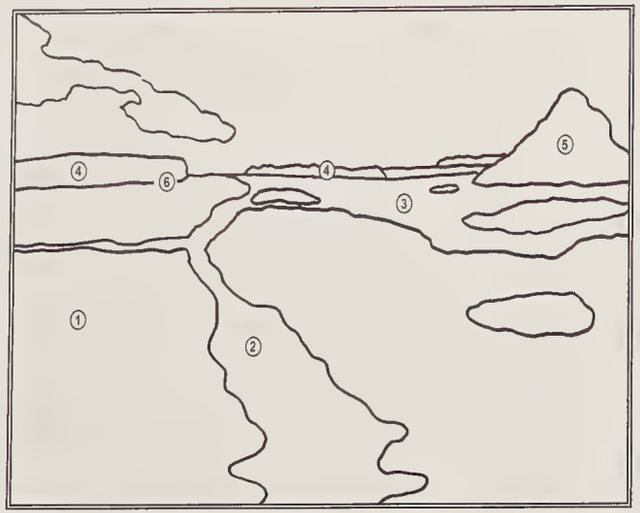
NORTHWEST PASSAGE

Arctic Archipelago Ecozone

From Greenland in the east to Alaska in the west, the Arctic Archipelago Ecozone has lured mariners for centuries. The hope that a northerly route could be found to the Orient attracted many of the earliest explorers to the arctic. History has recorded the hardships and, indeed, the tragedies which often happen to these ventures. Local geographical names like Franklin District, Victoria Island, Sverdrup Islands, Norwegian Bay, and Prince Albert Sound are tributes to the varied people and nations that have explored the region.

This is perhaps one of the most unusual marine ecozones. Vast and open seascapes are rare. Instead, the marine area is comprised of a patchwork of interconnecting bays, fjords, channels, straits, sounds and gulfs. This lattice of marine water bodies surround hundreds of islands such as the Queen Elizabeth chain of islands, Baffin Island, Melville Island, Devon Island and Banks Island. The islands form large parts of two arctic terrestrial ecozones–the Arctic Cordillera and the Northern Arctic. The marine and terrestrial ecozones are inextricably interrelated. Species like polar bear and Arctic Terns, for example, roam between the land and the sea.

This setting is relatively unique on a circum-polar basis. The general boundary of the ecozone follows the northern continental shelf from Mackenzie Bay in the Beaufort Sea north to the Lincoln Sea between Ellesmere Island and Greenland. It then curves south through Nares Strait, taking in all of Baffin Island, save for sections of the east coast considered part of the Northwest Atlantic Ecozone. The ecozone encompasses all waters to the west of Baffin Island, including the Gulf of Boothia and Foxe Basin, and then extends south into one of Canada's most prominent geographic features, Hudson Bay.



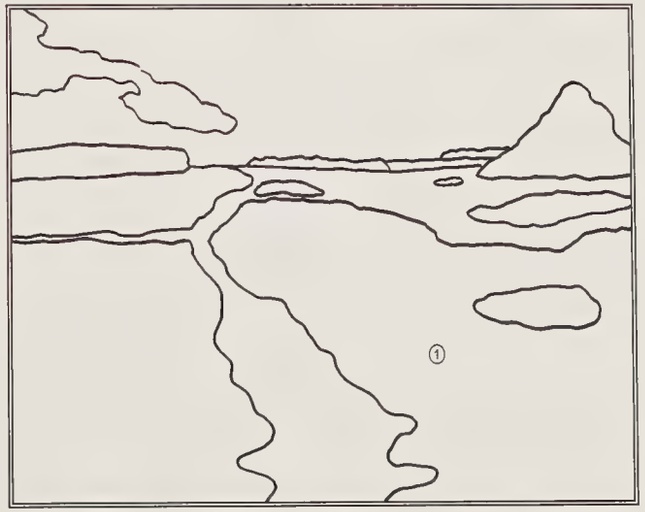
1. Sea ice
2. Leads
3. Open water
4. Islands
5. Iceberg
6. Beach

LANDFORMS AND CLIMATE

The coastlines in this ecozone vary considerably. Precipitous fjords and cliffs are common around the coasts associated with Baffin Basin, Lancaster Sound and Nares Strait whereas areas to the west like the Foxe Basin, Amundsen Gulf and Viscount Melville Sound have flat to rolling coastal plains. Water depths of 150 to 500 metres are typical. Deeper water starts to occur when this ecozone merges with the Northwest Atlantic Ecozone; around Baffin Bay, depths can start to approach 1000 metres. Massive glaciers along Baffin and Ellesmere islands often reach from the mountain tops and into the sea. On eastern Ellesmere Island, glaciers extending into the sea break off or "calve" huge icebergs into Nares Strait.

During the winter, sea ice is jammed fast to the land and extends over the seas as a solid sheet. Polynyas, localized breaches in the ice where currents and upwellings create open water, can occur throughout the ecozone. The ice cover reaches its maximum thickness in May. In the brief spring and summer periods, the ice will breakup. In the northwestern parts of the ecozone, the sea ice normally shatters into massive sheets that are separated by narrow channels of open water. The sea ice persists throughout the summer. In the rest of the ecozone, the ice is more seasonal. In summer, the massive sheets of ice fracture, drift and melt away. The process can be very dramatic. Shorelines can be markedly scoured by drifting fragments of ice or huge log-jams of ice can be driven up on the beaches. As the summer periods proceeds, open water can be found further and further north. From year to year, ice conditions are so variable and unpredictable, however, that mariners and navigators of even the most technologically advanced ships can still find themselves blocked. By September, most of the sea ice in the south easterly parts has either melted or drifted away on southerly currents.

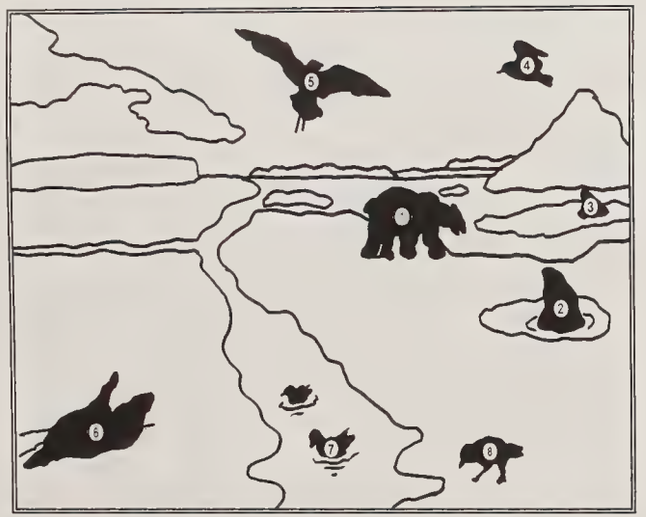
The short cool summers of the Land of the Midnight Sun give way to long cold winters. Long periods of daylight in the summer help stretch the short growing season, but air temperatures remain stubbornly chilly. Even in July, mean daily temperatures average just 10°C. In winter, temperatures average about –30°C, and often much lower. In the southern range of the ecozone lie Hudson and James bays, where the waters are amongst the shallowest (50 to 150 metres) and the climates are the most temperate.



1. Barren icesheets

PLANTS

In the high Arctic, snow-covered sea ice absorbs much of the solar radiation necessary for photosynthesis. But by late summer, the ice has thinned enough to allow a seasonal bloom of tiny plants called phytoplankton. The largest natural upwelling of sea water in the ecozone is the North Water Polynya. It occurs in northern Baffin Bay near Nares Strait, encouraging an earlier and more prolific bloom of phytoplankton than elsewhere in the ecozone. Further south, inter-tidal zones support forests of kelp.



1. *Polar bear*
2. *Beluga whale*
3. *Walrus*
4. *Ross' gull*
5. *Yeager*
6. *Seal*
7. *Glaucous gull*
8. *Common tern*

WILDLIFE

During the brief arctic summer, dozens of species of migrating birds make use of the unpredictable sections of open water that appear in the ecozone. As the pack ice breaks up, ice edges become vital areas for mammals and seabirds. Taking advantage of the conditions there to feed, stage, and moult are small numbers of Tundra Swans, loons, geese, ducks, and several species of shorebirds, gulls, Jaegers, Arctic Terns, Alcids, and Fulmars.

Polar Bears and Ringed Seals roam throughout the region. Bearded and Harp Seals are found along the east coast of Ellsemere Island, where open waters promise easy breathing. In winter, the unfrozen North Water Polynya serves as a refuge for marine mammals. In the 19th and early 20th centuries, whalers hunted the Bowhead Whale almost to extinction. While their numbers have rebounded in western waters, the eastern stock is still severely depleted and the species is considered endangered.

Large schools of small Arctic Cod exist across the ecozone supporting populations of seals, Beluga Whales and Narwhals. It has been estimated that seabirds and marine mammals consume 148 000 tonnes of these fish annually in Lancaster Sound alone. Arctic Char are plentiful in the Queen Maud Gulf, shrimp thrive in the south Baffin and Hudson Strait waters, and scallops are found off south Baffin Island and in Hudson Bay.

Important but threatened pods of the Beluga Whale spend their summers along the west coast of Hudson Bay. The largest population of Polar Bears in Canada builds dens along the coast of Hudson Bay near Churchill, Man. The tidal flats and salt marshes of the bay also welcome some of the world's largest concentrations of breeding and migrating waterfowl. One of the largest known populations of Peregrine can be found along the northwest coast.

1. *Tourism, hunting and trapping*
2. *Oil and gas exploration*

HUMAN ACTIVITIES

The waters of the Arctic Archipelago Marine Ecozone wash the shores of three provinces and two territories. Biologically, it is as least as productive as the adjacent lands. Canada's Inuit find most of their traditional food in this ecozone, so hunting and fishing remain significant human activities. While it is common to think of the arctic in the context of European explorers, the Inuit have a rich and varied culture that well predates their involvement. Arctic Char and Greenland Halibut (turbot) support commercial fisheries in Baffin Bay. Oil and gas exploration and development provide economic opportunities but still continue to pose environmental threats to the ecozone, especially in the Beaufort Sea. As mineral prospectors gain more experience in northern latitudes, large mineral deposits may be found, raising questions about mine waste and tailings that could find their way into the sea.

To the south, it seems inevitable that hydroelectric development will continue on the rivers draining into James Bay. Changes in water flow, salt content, and the presence of heavy metals leached from the soil will have unpredictable consequences for the southern portion of the ecozone. The impacts of urbanization will continue as human populations grow, especially in the more southerly reaches. The long-range transport of pollutants from places as far away as Mexico have impacts on the arctic. PCBs, DDT, and mercury are examples of pollutants affecting this ecozone as well as other parts of the Arctic.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

17. NORTHWEST PASSAGE

FURTHER READING

Banfield, A.W.F. 1974. The Mammals of Canada. Toronto: University of Toronto Press. ISBN 0-8020-2137-9

Boden, J. F. and E. Boden, eds. 1991. Canada North of Sixty. Toronto: McClelland and Stewart Inc. ISBN 0-7710-1581-X

Bone, R. 1992. The Geography of the Canadian North. London: Oxford University Press. ISBN 0-19-540772-5

Government of Canada. 1991. The State of Canada's Environment. Ottawa: Minister of Supply and Services Canada. ISBN 0-660-14237-6

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Government of Canada. 1994. A Marine Ecological Classification System for Canada. Draft Report. Marine Environmental Quality Advisory Group. Ottawa: Environment Canada.

Government of Canada. 1994. The Inuit Economy – sustaining a way of life. A State of the Environment Fact Sheet. Ottawa: Environment Canada. ISBN 0-662-21528-1. http://www.doe ca/soer/inuit.html

Government of Canada. 1995. Sea to Sea to Sea: Canada's National Marine Conservation System Plan. Department of Canadian Heritage. Ottawa: Minister of Supply and Services Canada. ISBN 0-662-23045-0

Renewable Resources. Various Dates. NWT Wildlife Sketches. (Thirteen brochures on selected wildlife species.) Yellowknife: Government of the Northwest Territories

Rogers, Stan. 1981. Northwest Passage. Dundas, Ontario. Fogarty's Cove Music Inc. FCM 004D.

Welch, Harold E. 1995. Marine Conservation in the Canadian Arctic: A Regional Overview. Ottawa: Arctic Resources Committee, Northern Perspectives, Volume 23, Number 1, Spring 1995.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by William J. Johnson of Fine Art Studio, London, Ont.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid and many others – and some of the work was written under contract to Kenneth Lawton Communications. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

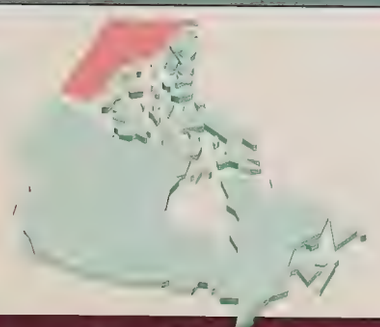
Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

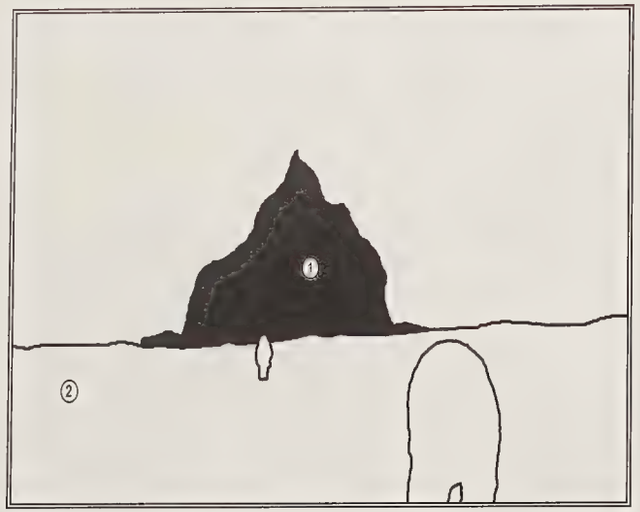
Environment Canada Environnement Canada



THE GIANT ICE CAP

Arctic Basin Ecozone

Most of the traditional impressions which people have about Canada's Arctic are defined by the Arctic Basin Ecozone. This is essentially the parts of the Arctic Ocean that remain under permanent ice cover. It extends from the southern edge of the permanent ice line in the Beaufort Sea north and east over the Canada Basin of the northern tip of Greenland. It skirts the northern edge of the Queen Elizabeth Islands and touches the northern coast of Ellesmere Island. The overwhelming ecological characteristic of this ecozone is the constant cover of ice sheets and pack ice. More than 90% of the region consists of a giant permanent ice cap floating on the ocean. It slowly rotates in a counter-clockwise pattern, roughly centred on the North Pole. The rotation is driven by the Arctic Ocean Gyre, one of the main ocean currents. The heavily ridged ice reaches a thickness of 2 metres or more and islands of ice several kilometres square are common.

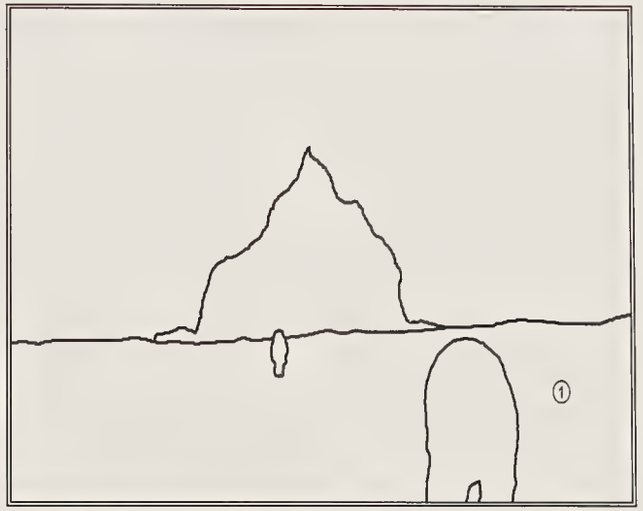


1. Iceberg
2. Icesheet

LANDFORMS AND CLIMATE

The Arctic Basin Ecozone is a true oceanic ecozone in that it touches almost no land except the north coast of Ellesmere Island. The undersea geography is dominated by the Canada Basin, which plummets to an average depth of about 3 600 metres. The Canada Basin extends from the Beaufort Sea almost to the North Pole, where it is bounded by the Lomonosov Ridge, a submarine mountain range rising to 1 000 metres below the ocean surface. Near the southern margin of the permanent ice pack, the Mackenzie River discharges a considerable plume of fresh water into the Beaufort Sea in the neighbouring Arctic Archipelago Ecozone.

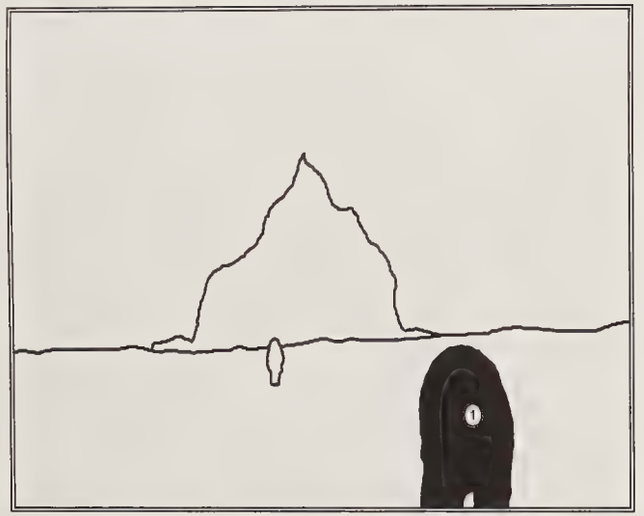
The climate is extremely cold and dry. In January, mean daily temperatures range from -30 to -35°C. In summer, the mean daily temperature rises only to a chilly 5°C. Annual precipitation ranges from 100 to 200 mm – sparse compared with St. John's, Nfld., Canada's precipitation capital with 1 500 mm a year. And yet, against these most extreme conditions, there is life in Canada's Arctic.



1. Ice barrens

PLANTS

Icy conditions offer a daunting habitat, but arctic marine plants are tenacious. Because of the constant ice cover and an almost total absence of tides, the waters of the Arctic Basin do not mix as they do in other oceans, so there is no opportunity for the introduction of nutrients from other ecozones. In fact, biological productivity in the ecozone is only 1% of the well-mixed Atlantic Ocean. Despite these obstacles, algae grows on the underside of sea ice in the summer. Biological hotspots consisting of blooms of microscopic plants known as phytoplankton occur in spring and summer along the edges of the pack ice or in stretches of open water, called polynyas, where currents are strong enough to keep the water from freezing. These blooms are the basis of the Arctic food chain.

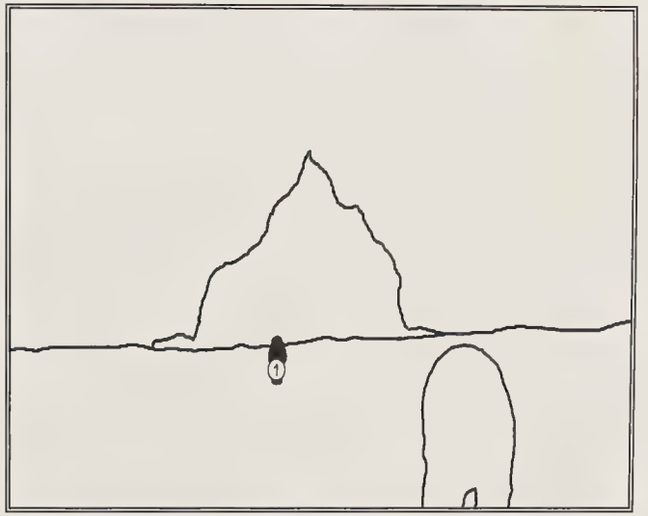


1. Polar bear

WILDLIFE

Thanks to phytoplankton and algal blooms, some higher animal species manage to eke out a living in this hostile environment and have adapted to life on or near the permanent ice pack. Life tends to be truly on the edges here. Along the more southerly borders of this ecozone live Walrus, Polar Bears, Beluga Whales, Narwhals, and Bearded, Harp, Ringed and Harbour Seals. Migratory birds pass through the ecozone, and a hardy arctic survivor, the bold and aggressive Ivory Gull, lives year-round here. This bird will eat anything it can find, including fish, crustaceans, and dead whales and seals. The remains of a seal killed by a Polar Bear provide a rare bonanza.

Life is present beneath the ice, but it is sparse compared with warmer waters. About 130 species of fish occur across the Arctic. The greatest numbers occur in the west and south, with schools of Arctic Cod and Ogac, Arctic Char, Sculpin, Eelpout, and Snailfish the most common. It is estimated that half the living creatures in the Arctic are benthic, or bottom-dwelling, organisms such as anemones, clams, sea worms and sea stars. But even today, little research has been carried out, and little is known about these creatures other than that they are crucial to the Arctic food web.



1. Exploration/science

HUMAN ACTIVITIES

Most of the Canadian Arctic remains unexplored. Since the ecozone touches almost no land, human presence is limited to small-scale hunting parties along the edges of the pack ice and to adventurers willing to risk the fierce cold and near-featureless ice to fulfill their dreams of conquering the North Pole. In recent years, aircraft and ice-breaking ships have carried scientists and even tourists into the area. Scientific expeditions have concentrated largely on finding oil and gas reserves along the edges of the ice pack, but the permanent ice offshore poses formidable challenges to petroleum exploration and drilling.

Scientists have tracked the spread of toxic chemicals through the food chain in the Arctic. These substances, such as PCBs, DDTs, and mercury and other heavy metals, are released in distant industrial centres and transported to the Arctic by global weather systems and ocean currents. They tend to build up in the bodies of the marine mammals used by Canada's aboriginal peoples as major sources of food. PCBs, for example, are a known contaminant in the breast milk of Inuit women. Commercial over-harvesting of mammals and birds has endangered wildlife populations, most notably the Bowhead Whale. Commercial exploitation of traditional country foods has also affected Inuit subsistence hunting patterns.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cprc/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

18. THE GIANT ICE CAP

FURTHER READING

Boden, J.F. and E. Boden, eds. 1991. Canada North of Sixty. Toronto: McClelland and Stewart Inc. ISBN 0-7710-1581-X

Bone, R. 1992. The Geography of the Canadian North. London: Oxford University Press. ISBN 0-19-540772-5

Dunbar, M. J. 1968. Ecological Development in Polar Regions. Prentice-Hall, Englewood Cliffs, New Jersey.

Dunbar, M. J., and Moore, D. M. 1980. Marine life and its environment in the Canadian Eastern Arctic: A biogeographic study. Marine Science Centre Manuscript No. 33. , Montreal: McGill University.

Dunbar, M. J. 1988. Marine Regional Boundaries in the Canadian North: Foxe Basin, Hudson Strait, Hudson Bay and James Bay. Report prepared for the Canadian Parks Service, Ottawa.

Government of Canada. 1991. The State of Canada's Environment. Ottawa: Minister of Supply and Services Canada. ISBN 0-660-14237-6

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Government of Canada. 1994. A Marine Ecological Classification System for Canada. Draft Report. Ottawa: Marine Environmental Quality Advisory Group. Environment Canada.

Government of Canada. 1994. The Inuit Economy – sustaining a way of life. A State of the Environment Fact Sheet. Environment Canada. ISBN 0-662-21528-1

Government of Canada. 1995. Sea to Sea to Sea: Canada's National Marine Conservation System Plan. Department of Canadian Heritage. Ottawa: Minister of Supply and Services Canada. ISBN 0-662-23045-0

Renewable Resources. Various Dates. NWT Wildlife Sketches. (Thirteen brochures on selected wildlife species.) Yellowknife: Government of the Northwest Territories.

Welch, Harold E. 1995. Marine Conservation in the Canadian Arctic: A Regional Overview. Ottawa: Arctic Resources Committee, Northern Perspectives, Volume 23, Number 1, Spring 1995.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Serge Bedard, Gatineau, Quebec

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid and many others – and some of the work was written under contract to Kenneth Lawton Communications. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA)

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

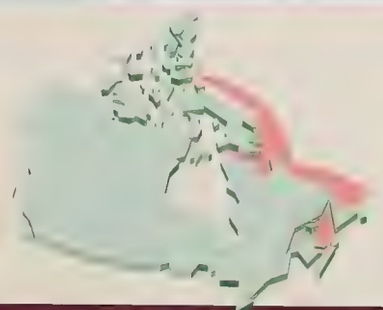
Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada

Northwest Atlantic Ecozone

The Northwest Atlantic Ecozone begins in Canada's Far North at the mouth of Lancaster Sound. It continues south along the eastern edge of Baffin Bay, touching Baffin Island at Cape Dyer. It takes in the remaining coast of Baffin Island, rounds Resolution Island and heads west to Hudson Strait. Arcing east, the ecozone encompasses Ungava Bay and all of the Labrador Coast, the west and northeast coasts of Newfoundland, and the entire Quebec, New Brunswick, P.E.I. and Nova Scotia coasts of the Gulf of St. Lawrence. Offshore, it follows the outer edge of the underwater continental shelf, descending south from the permanent ice sheet near Davis Strait to come ashore at Newfoundland's Avalon Peninsula.



ATLANTIC EDGE

1. *Coastal highlands*
2. *Cloud cover/fog*
3. *Coastal beach*
4. *Coastal island*
5. *Ocean*
6. *Peninsula*
7. *Iceberg*

LANDFORMS AND CLIMATE

Much of the immense coastline contained in the ecozone is characterized by fjords, cliffs, and bald rock created by advancing and retreating glaciers about 10 000 years ago during the last Ice Age. There are more than 440 000 islands along the coasts. Offshore, the continental shelf extends to a distance of about 150 kilometres, with water depths from 200 to 300 metres. Within the ecozone, tides range from 9 to 12 metres. In parts of the Gulf of St. Lawrence, tidal action is much smaller, with average fluctuations of less than a metre. However, tides to challenge those of the Bay of Fundy occur in Ungava Bay.

Like the Pacific Marine Ecozone, the Northwest Atlantic forms a transition between the cold northern waters and the more temperate southern waters. Major ocean currents flow through it – cold arctic waters carried south by the Labrador Current merge near the Grand Banks with the warmer flow of the Gulf Stream. Average temperatures differ by more than 20°C between the arctic waters and the Gulf Stream. In August, surface temperatures vary between 3 and 8°C. Beneath the surface, temperatures remain below 0°C year round, but sea salt prevents the sub-surface waters from freezing solid. In the Gulf of St. Lawrence, fresh water flowing from the St. Lawrence River keeps the salt levels lower.

Sea ice is common throughout much of the ecozone, depending on the season and latitude. Ice begins to form off the coast of Labrador in November or December. By February or March, ice regularly reaches the northeast coast of Newfoundland and the Grand Banks, accompanied by thousands of icebergs. Most years, the St. Lawrence River freezes over, closing shipping. In May or June, the ice begins to clear and, by July, the coasts are ice-free well north on the coast of Labrador.

1. *Near shore barrens*
2. *Coastal forest*

PLANTS

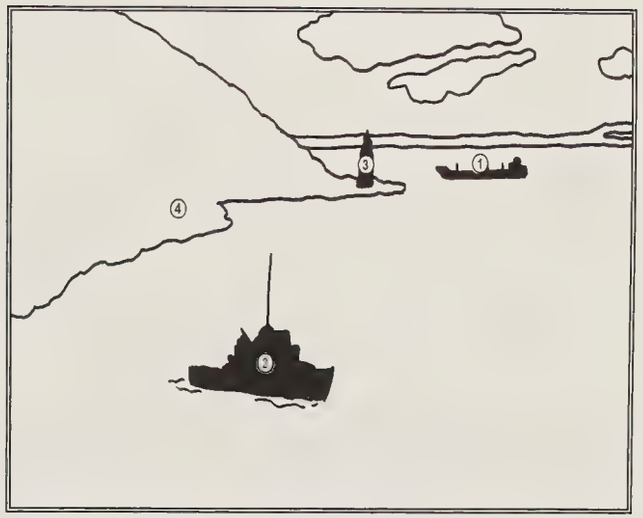
In the northern reaches of the ecozone where sea ice predominates, plant life is limited to species of algae and benthic organisms, such as anemones, that live on the ocean floor. Conditions further south are favourable for varieties of phytoplankton, algae, kelp and seaweeds. Coastal intertidal zones are particularly productive and provide shelter and food for a diverse community of marine animals that include such familiar residents as mussels, lobsters and crabs.

1. *Porpoises*
2. *Puffin*
3. *Fin whale*
4. *Seal*
5. *Herring gulls*
6. *Gulls*

WILDLIFE

The waters over the continental shelf of the Northwest Atlantic are famous for their prolific communities of marine mammals, birds, and fish. It is home for part of the year to the now-famous endangered Northern Cod. Twenty-two species of whale and six species of seal occur in the ecozone. Pods of Humpback, Sei, Fin, and Minke Whales are most likely to be spotted, along with the occasional Blue Whale. Sperm Whales can be found further offshore. Orcas, porpoises and dolphins also occur, but are not common. Millions of Harp Seals live along the coasts. There is debate as to whether Harp Seals share some of the blame for the decline of the cod stocks.

Steep, rocky cliffs and thousands of islands provide ideal habitat for some of the largest seabird colonies in the world. Concentrations occur on the Gannet Islands off the southern Labrador coast and the Funk Islands off Newfoundland's northeast coast. Large colonies of Puffins, Petrels, Cormorants, Thick-billed Murres, and several varieties of gull also nest in the Gulf of St. Lawrence on Anticosti Island, Bonaventure Island, and the Magdalen Islands.



1. *Shipping*
2. *Fishing*
3. *Coastal navigation*
4. *Tourism*

HUMAN ACTIVITIES

The richness of the Atlantic Ocean lured Europeans to the ecozone's waters in the 16th century and there is evidence of Norse and Spanish fishing settlements in the preceding centuries. Legendary quantities of fish were scooped out of the waters off the east coast. It became an accepted and lucrative notion that there were more fish in the sea than could ever be harvested. The sea provided a sometimes meagre living for fishing families, while enriching merchants and financiers. But by the 1990s, national and international fishing fleets had nearly wiped out Canada's cod stocks. A way of life that supported the people of eastern Canada for 400 years was in jeopardy. In 1992, the government of Canada imposed a moratorium on cod fishing in most Atlantic Canadian waters in hopes the stocks would rebuild.

The northern reaches of the ecozone are sparsely populated. Small towns and villages dot the Newfoundland and Labrador coasts and Baffin Island. Human activities include seal hunting, subsistence fishing, resource exploration and burgeoning tourism. But large offshore trawlers still take their official quotas – sometimes more – of any commercially valuable fish they can find. Concern is now emerging about the imminent exploitation of giant mineral deposits recently found at Voisey's Bay on the northern Labrador coast. Some wonder how the mines will avoid polluting the streams and rivers that run to the ocean.

Population density increases dramatically further south along the shores of the Gulf of St. Lawrence, which suffers from the effects of industrial and municipal sewage. Endangered marine mammals, such as the Beluga Whale, are sensitive to toxins in the water. Urban sprawl along the banks of the St. Lawrence River and around coastal cities has destroyed much wildlife habitat. Municipal garbage dumps have encouraged gull populations to rise, forcing out other species.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness, ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A OH3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems; frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

19. ATLANTIC EDGE

FURTHER READING

Beanlands, G. B. 1983. Land use pressures on coastal estuaries in Atlantic Canada. Coastal Zone Management Journal, Vol. 11, Nos. 1-2:117-132.

Breton, Mimi. Guide to Watching Whales in Canada. Ottawa: Fisheries and Oceans, Information and Publications Branch, 1986. Gov't Doc. No. DSS Cat. no. FS23-78/1986E

Government of Canada. 1991. The State of Canada's Environment. Ottawa: Minister of Supply and Services Canada. ISBN 0-660-14237-6

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Government of Canada. 1994. A Marine Ecological Classification System for Canada. Draft Report. Marine Environmental Quality Advisory Group. Ottawa: Environment Canada.

Government of Canada. 1994. Progress Report on the Northern Cod Science Program. Communications Branch, Department of Fisheries and Oceans. Ottawa: Minister of Supply and Services Canada. ISBN 0-662-22677-4

Government of Canada. 1994. The State of the Environment in the Atlantic Region. Ottawa. Minister of Supply and Services. http://www.ns.ec.gc.ca/soe/toc.html

Government of Canada. 1995. Sea to Sea to Sea: Canada's National Marine Conservation System Plan. Department of Canadian Heritage. Ottawa: Minister of Supply and Services Canada. ISBN 0-662-23045-0

McCay, B. and Finlayson, A. C. 1995. The Political Ecology of Crisis and Institutional Change: The Case of the Northern Cod. Rutgers State University, New Jersey. http://www.lib.uconn.edu/ArcticCircle/NatResources/cod/mckay.html

Wilson, R., and Addison, R. (eds.). 1984. Health of the northwest Atlantic. Department of the Environment/Department of Fisheries and Oceans/Department of Energy, Mines and Resources.

Wiken, E 1986. Terrestrial Ecozones of Canada. Ecological Land Classifications Series No. 19. Ottawa: Environment Canada. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by William J. Johnson of Fine Art Studio, London, Ont.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid and many others – and some of the work was written under contract to Kenneth Lawton Communications. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas(CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

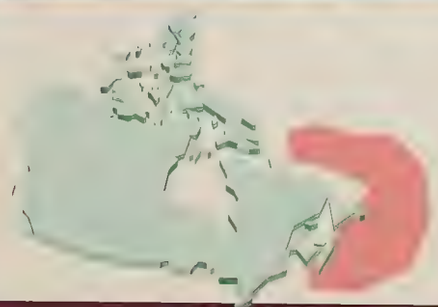
Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

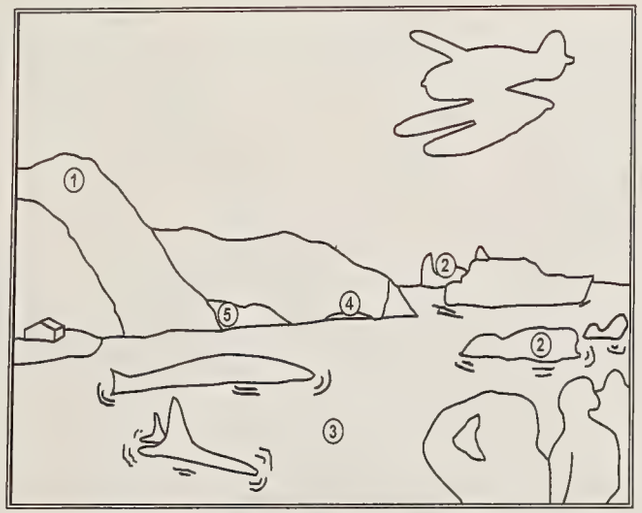
Environment Canada Environnement Canada

Atlantic Marine Ecozone

With the exception of the Grand Banks and the Scotian Shelf, the Atlantic Marine Ecozone is defined by deep water. Its offshore boundary wanders along the edge of the eastern continental shelf and about half of the ecozone is located well out to sea. It begins in the Davis Strait, follows the Labrador Shelf south around the Flemish Cap seamount, takes in the Grand Banks, and comes ashore at the northeastern tip of Newfoundland's Avalon Peninsula. The inshore boundary encompasses all of Newfoundland's south coast and Nova Scotia's east coast, and extends into the Bay of Fundy and south to the Gulf of Maine. Icebergs seemingly the size of small mountains, with 90% of their mass underwater, are not uncommon and have been feared by mariners for centuries. Because of the danger of collisions with icebergs, sailors named the stretch of ocean from Greenland to the southern coast of Newfoundland "Iceberg Alley."



ICEBERG ALLEY



1. *Coastal lowlands and mountians*
2. *Icebergs*
3. *Ocean*
4. *Beach*
5. *Fjord inlet*

LANDFORMS AND CLIMATE

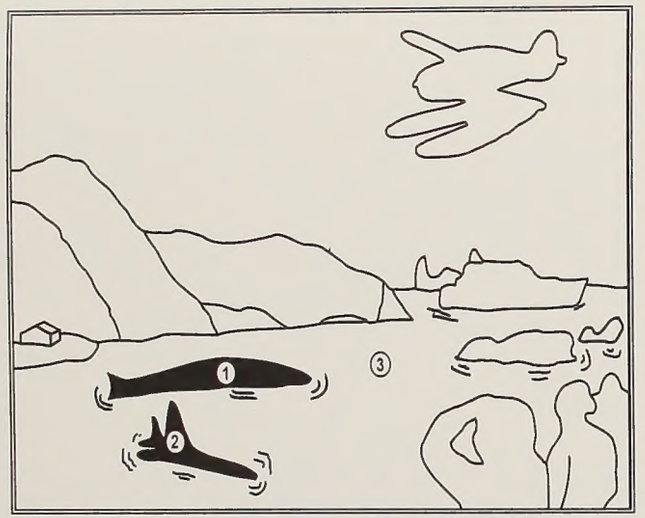
Off the coast of Labrador, the Atlantic Marine Ecozone essentially begins at the edge of the continental shelf and travels east out to sea. But east and south off Newfoundland lie the relative shallows of the Grand Banks, the trailing edge of the great North American tectonic plate. Average water depths outside the shelf can reach down thousands of metres, with depths on the Grand Banks of less than 150 metres over broad areas. Tidal ranges within the ecozone are normally one to two metres, but the Bay of Fundy is the exception, with its famous tidal bores topping 15 metres.

The ecozone is generally temperate due to the influence of the massive Gulf Stream. Prevailing winds blowing off the land from the west and southwest also moderate the ocean climate. In August, surface water temperatures can vary between 10 and 23°C. But like the Northwest Atlantic Ecozone, winter and early spring ice can be plentiful along the east coast of the Avalon Peninsula and in the Cabot Strait between Newfoundland and Nova Scotia. Icebergs are a common sight in late winter and spring off the Newfoundland coast and on the Grand Banks. The mainland coast of Nova Scotia and the Bay of Fundy (except for its northernmost reaches) are essentially ice-free. Off Newfoundland, mixing of the warm currents from the south and the Labrador Current from the north produces some of the most famously dense fog banks on the planet.

1. *Coastal barrens*

PLANTS

Phytoplankton blooms that can turn the water green with life every spring are the first link in the food chain of the Atlantic Marine Ecozone. Marine plants such as seaweeds and kelp are prolific, especially in intertidal zones. Extensive salt marshes occur throughout the zone, particularly in New Brunswick, Nova Scotia, and Prince Edward Island, but less frequently in Newfoundland and Labrador. These tidal wetlands are home to the highly salt-resistant Saltmarsh Cord Grass and Marsh Meadow Grass. The salt marshes can also support a variety of other plants, including Spike Grass, Wild Barley, Sea Lavender and Sea Plantain.



1. Fin whale
2. Killer whales
3. Fish feeding area

WILDLIFE

The Grand Banks are among the most biologically productive marine areas in the world. The confluence of the Labrador Current and the Gulf Stream, and the tidal mixing of the water column on the shallows of the continental shelf, provide ideal feeding and spawning conditions for thousands of species.

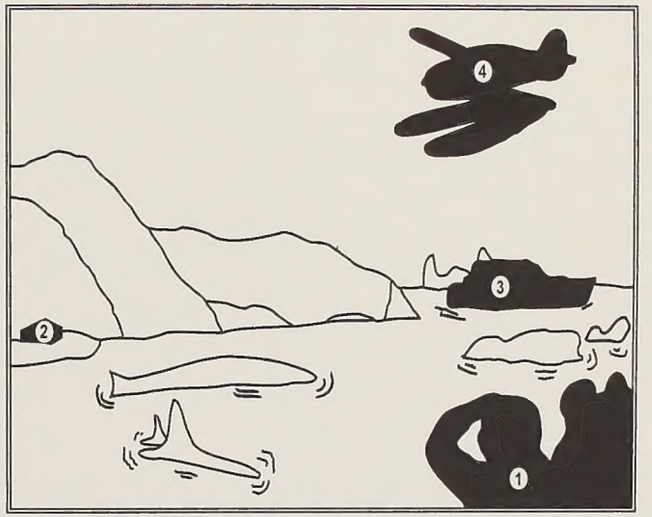
Benthic, or bottom-dwelling, communities are rich with invertebrates, such as barnacles, sea stars, crabs, lobster, sponges, scallops, clams and jellyfish, to name a few. Common fish populations historically included Northern Cod, Redfish, Herring, Silver Hake, and the now-famous Greenland Halibut, or turbot. The Northern Cod spends part of its life-cycle migrating between the Atlantic and the Northwest Atlantic marine ecozones. Thanks to chronic overfishing by Canada and other nations, commercial harvests of many of these species are no longer sustainable, and there are fears the once-rich Grand Banks cod may never again support a commercial fishery.

Common marine mammals in this ecozone include Harbour and Grey Seals, Harbour Porpoises, and dolphins. Several species of whale are indigenous to or migrate through the ecozone, including the Northern Bottlenose, Blue, Pilot, Beluga, Fin, Minke, and Humpback Whale.

Significant proportions of the North American or world populations of seabirds live within the ecozone. Large numbers overwinter on the open ocean off Newfoundland and Nova Scotia, only coming ashore to find mates. Among them are the Northern Fulmar, Greater Shearwater, Dovekie, and Common and Thick-billed Murres. Breeding colonies for Leach's Storm Petrel, Kittiwakes, Puffins, and Common Murres can be found on Newfoundland's Baccalieu Island and Witless Bay Islands. Cape St. Mary's hosts Gannets, Kittiwakes and Common Murres. Machias Seal Island in the Bay of Fundy supports large colonies of Puffins and Arctic Terns. And there are large populations of Shearwaters, Eiders and Cormorants, and gulls throughout the region.

The low-lying beaches, salt marshes and tidal flats of the Upper Bay of Fundy and the southern Gulf of St. Lawrence are dominated by burrowing crustaceans, such as Corophium and Annelid worms. These are extremely abundant at or just below the surface of the mudflats, and are fed upon by migratory birds and other shorebirds. This habitat is the product of the huge tidal fluctuations in the Upper Bay of Fundy, which top 15 metres.

Estuaries, where fresh river waters mix with saline sea water, are productive habitats. They serve as nursery areas for juvenile fish and the planktonic larvae of mollusks, crustaceans, and other invertebrates. The estuaries of the Gulf of Maine are thought to be vital to almost three-quarters of the commercially-significant fish species in the area.



1. Whale-watching, tourism
2. Fishing village
3. Shipping
4. Exploration

HUMAN ACTIVITIES

The Grand Banks of Newfoundland, once world-renowned for their seemingly limitless populations of cod, lie within the Atlantic Marine Ecozone. But four centuries of relentlessly evolving technology driven by ever-increasing took their toll on the cod. Canadian and foreign fishing fleets vacuumed the ocean of commercial fish. With the commercial extinction of cod a serious possibility, Canada banned cod fishing in 1992 in hopes the stocks would recover.

Fishing for other species such as lobster, shrimp, and crab still provides a livelihood for some families. Aquaculture is spreading, with experiments in salmon, scallop, and cod farming under way in New Brunswick, Nova Scotia, and Newfoundland. But the real hope for future economic development in the ecozone now lies with offshore oil and gas production. The rich Hibernia and Terra Nova oil and gas fields are buried there, as are reserves off Nova Scotia along the Scotian Shelf.

ECOZONES OF CANADA *by E. B. Wiken*

Most Canadians – about 77% – live in cities. Buildings, roads, utility lines, vehicles, and other people surround us. Apart from some parks and other urban green spaces, the "environment" is something that for the most part exists elsewhere, at some distance from the urban core.

Seen from space, however, Canada shows no roads, no political boundaries, no languages, no politics, and no people. The country's appearance is strikingly different from this distant perspective. It is surrounded by three massive oceans, contains a large share of the world's fresh water, and has 25% of the world's major wetlands. Vast stretches of land are occupied by the arctic barrens, the great plains, the forests, and the western mountains. Ocean currents swirl around the margins of the continent and weather patterns move over the land and ocean masses. Virtually hidden from this distant view are tens of thousands of species of plants and animals as well as more than 28 million human beings.

This faraway view of the nation is compelling because it forces us to think of ourselves as an integral part of the Earth's ecosystems, not separate from them. Just as images taken from space are relatively new, so too is the broad realization of the human partnership with the environment.

From bits and pieces

Glimpses from satellites and space shuttles remind us of the big picture: that we live within broad ecological zones on the Earth's surface. Ironically, our knowledge about those ecosystems has grown through a process that emphasized studying the bits and pieces and disregarding the whole.

As one of the largest nations on the globe, Canada has a diversity of landscapes and seascapes that is seemingly endless – temperate forests and arctic barrens, extensive river systems and coastlines, vast plains and imposing mountain ranges, farmscapes and wilderness , ranging from relatively untouched to highly stressed systems. The variety can be overwhelming. Naturalists, scientists, and many others have contributed to describing these natural zones. Some described biological features such as general vegetation, wildlife, habitat, and peatlands. Physical descriptions focused on climate zones, bedrock types, marine areas and soils. Other classifications specifically addressed types of human activity (e.g., rural land uses). These single-purpose studies are quite reliable tools for studying component parts of ecosystems. But in cases where it is important to understand the relationships between people and the environment, and between wildlife and wildlife habitat, the existing information tends to be rather piecemeal.

Problems with an incomplete view

Studying the component features of ecosystems has contributed to our understanding of Canada's biological and physical diversity. For the purposes of environmental management and sustainable resource use, however, this piece-by-piece approach has led to an incomplete and often misleading view.

There are those who are involved in the management of ecosystems and others who look at ecosystems from the standpoint of impact assessments, environmental indicators, economic factors, monitoring systems, or public reviews. There is so much work to be done in all these separate areas that we have been slow to develop an integrated and holistic approach. Yet without a broad ecosystem perspective, it is becoming increasingly difficult to address environmental goals. There are questions about the balances of land and water use to be answered; conservation and exploitation perspectives to be weighed; local and distant benefits and costs to be assessed; cumulative effects to be measured; and political, social, environmental, and economic values to be evaluated.

Canada has a mosaic of distinctive ecosystems, many of which are unique in the world. There are 20 major ecosystems – ecozones – in Canada: 15 terrestrial ecozones and 5 marine ecozones. The marine ecosystems cover parts of three major oceans settings – the Pacific, Atlantic and Arctic. The terrestrial ecozones largely cover a broad range of forested, taiga and arctic ecosystem types. Canada also has significant representation of ecosystems which were formerly native grassland areas.

SCIENTIFIC NAMES OF CANADIAN ECOZONES

Terrestrial			*Marine*
1. Arctic Cordillera	*6. Taiga Cordillera*	*11. Pacific Maritime*	*16. Pacific Marine*
2. Northern Arctic	*7. Hudson Plains*	*12. Montane Cordillera*	*17. Arctic Archipelago*
3. Southern Arctic	*8. Boreal Plains*	*13. Prairies*	*18. Arctic Basin*
4. Taiga Plains	*9. Boreal Shield*	*14. Atlantic Maritime*	*19. Northwest Atlantic*
5. Taiga Shield	*10. Boreal Cordillera*	*15. Mixedwood Plains*	*20. Atlantic Marine*

AN ECOZONE PERSPECTIVE

Many tools are used to convey the notion of ecosystems and their all-encompassing nature. Because people are accustomed to thinking in terms of defined spaces, of seeing their lot, municipality, or country represented on a map, depicting ecozones on a map is a fundamental starting point. Political maps show legally delineated spaces, such as city or provincial boundaries, but this type of mapped information is not of primary importance in the early stages of applying an ecosystem approach. In contrast, ecozone maps define spaces in an ecologically meaningful way. Expressing ecosystems as units on a map provides a basis for understanding their structure and composition.

Common sense and ecosystem concepts

What is meant by an *ecozone*? People intuitively capture the meaning by the simple phrases they use to describe the large ecological areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the prairie grasslands, the plains Indians, the great central plains, Canada's breadbasket, the ranching heartland, the home of the buffalo, the nation's largest farmscape, the prairie climate, the grassland soils, big sky country, and the prairie wetlands and potholes.

Beyond expressing something about the obvious characteristics of the area, these phrases fashion a broader impression of a specific geographical location and of a vast open space. The mere word "prairies" evokes an image of large expanses of grain or rangelands that cover the southern parts of Alberta, Saskatchewan, and Manitoba. The phrases equally start to describe particular biophysical features and underlying relationships. The prairies have been a valued cereal grain production area for many decades. What interactions among environmental, economic, and cultural elements have caused this to be so? Many factors are connected to why the region is so productive for agriculture – the deep and nutrient-rich soils, the extensive tracts of flat or gently rolling land, the inherent adaptability of grassland species, the ease of cultivation, the warm, dry climate, and so on. Common sense tells us about the uniqueness of an area like the prairies.

Ecosystems can be of any size. They may refer to local wetlands, the Gulf of St. Lawrence, the circumpolar arctic area, or the entire Ecosphere. Big or small, they are part of a continuum – like a family, a community, or a nation – the components of which interact with and affect one another. The trends and conditions that are associated with the bigger ecozone units must be put in the context of what happens locally, in ecodistricts, as well as in ecosystems of global scale. If the reproduction of eastern migratory birds is weakened, for instance, the effects of the population declines reverberate throughout North America. The arctic ecozones are affected by ocean ecosystems that originate from as far away as the equator, by migratory birds that winter in Mexico, and by pollution that emanates from Russia's industrial heartland.

Defining ecozones

How is an ecozone determined? What were the key diagnostic characteristics for each Canadian ecozone? Were the same characteristics used for each? Which characteristics are essential and which are incidental?

In part, the answer to these questions is based on what common sense would suggest. In any large ecosystem – the forested mountains of the west coast, the arctic lowlands of the Northwest Territories, the great plains of the prairie provinces – the particular *combinations* of characteristics like climate, landforms, soils, plants, animals, and human activities are distinctive. These combinations remain relatively constant for each ecosystem.

Standards and guidelines exist for describing ecosystems (Wiken 1986; ESWG,1996). Ecozones still have to be judged on a case-by-case basis. Characteristically, they are large units (i.e., greater than 200 000 km²). Most of the diagnostic features are factors normally thought of as natural – landforms, soils, water features, vegetation, climate. However, where human activities are extensive and are key to sustaining the character of the area, they are also diagnostic. Agricultural activity is a fairly diagnostic feature of the Prairies ecozone; the occurrence of certain types of soils, the plains physiography, the former extent of native grasslands, and other features would also be considered in determining the boundary and traits of this particular zone.

Ecozones vary in shape and size. The largest in Canada – the Boreal Shield ecozone – is an irregularly shaped area stretching across parts of six provinces. It is bigger than the state of Alaska, the country of Mongolia, and the province of Quebec. It takes less time to fly from New York to London, England, than it would to fly the length of the Boreal Shield. Ecozones vary in diversity as well. For instance, the Prairies ecozone is less diverse than the Pacific Maritime ecozone. The Pacific Maritime unit is a lot like a layer cake. Temperate rain forest dominates much of the lower and mid elevations, but the base includes areas such as semi-Mediterranean arbutus and Garry Oak woodlands while, several layers higher up, alpine meadows and snow packs dominate.

Ecozones also differ with respect to their opportunities and constraints for particular activities and uses, such as agriculture, forestry, fishing, and recreation. For instance, although agriculture is successful in many areas across the country, it is predominantly associated with the Prairies and Mixedwood Plains ecozones.

Some of Canada's ecozones are shared with other countries. For example, the seemingly small Prairies ecozone (450 000 km²) is, in fact, only the northern tip of a unit that reaches well into the heartland of the United States. This ecozone also forms part of the world's set of temperate grasslands. Similarly, Canada's arctic ecozones form a vital segment – about 20% – of the world's total arctic ecosystems.

Further reading

Canadian Council on Ecological Areas (CCEA). 1995.
An introduction to Canadian ecozones. Fact-sheet No.1. Hull, Quebec. K1A 0H3. http://www.cas.uregina.ca/~cpre/ccea/

Ecosystem Working Group. 1996.
An ecological framework for North America. Technical Publication. Commission for Environmental Cooperation (CEC). Montreal, Quebec. H2Y 1N9

Ecological Stratification Working Group. 1996.
A national ecological framework for Canada. Ottawa: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research; and Ottawa: Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch.

Wiken, E.B. 1986.
Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Environment Canada. Hull, Quebec. 26pp. + map.

Wiken, E. B. 1996.
Ecosystems: frameworks for thought. in World Conservation. Volume 27, Number 1. IUCN, Gland, Switzerland.

20. ICEBERG ALLEY

FURTHER READING

Godfrey. W. E. 1986. The Birds of Canada. Ottawa: National Museums of Canada. ISBN 0-660-10758-9

Government of Canada. 1991. The State of Canada's Environment. Ottawa: Minister of Supply and Services Canada. ISBN 0-660-14237-6

Government of Canada. 1996. The State of Canada's Environment-1996. Environment Canada. Ottawa, Ont.

Government of Canada. 1994. A Marine Ecological Classification System for Canada. Draft Report. Marine Environmental Quality Advisory Group. Ottawa: Environment Canada.

Government of Canada. 1994. Progress Report on the Northern Cod Science Program. Communications Branch, Department of Fisheries and Oceans. Ottawa: Minister of Supply and Services Canada. ISBN 0-662-22677-4

Government of Canada. 1994. The State of the Environment in the Atlantic Region. Ottawa: Minister of Supply and Services. http://www.ns.ec.gc.ca/soe/toc.html

Government of Canada. 1995. Sea to Sea to Sea: Canada's National Marine Conservation System Plan. Department of Canadian Heritage. Ottawa: Minister of Supply and Services Canada. ISBN 0-662-23045-0

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Environment Canada. Ottawa, Ont. ISBN 0-662-14761-8.

CREDITS

Based on the Terrestrial Ecozones of Canada (Wiken, 1986), this series was developed by State of the Environment Directorate staff of Environment Canada to capture the representative elements of each ecozone using an artistic depiction and providing descriptive text.

Artwork was done under contract by Serge Bedard, Gatineau, Quebec.

Most of the text was written by Environment Canada staff – Ed Wiken, John Reid and many others – and some of the work was written under contract to Kenneth Lawton Communications. Sources of information came from a number of organizations including other government departments, universities, non-governmental groups and consultants.

Final copy editing was done by West Hawk Associates in Ottawa.

Information and reviews were provided by the Canadian Council on Ecological Areas (CCEA).

Design of the poster was completed by Accurate Design and Communication Inc. of Nepean, Ontario.

For further information, check out the State of Canada's Environment site on the Internet: http://www.ec.gc.ca

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

ISBN: 0-660-16665-8 Cat. No.: En21-157/1996E

Environment Canada Environnement Canada